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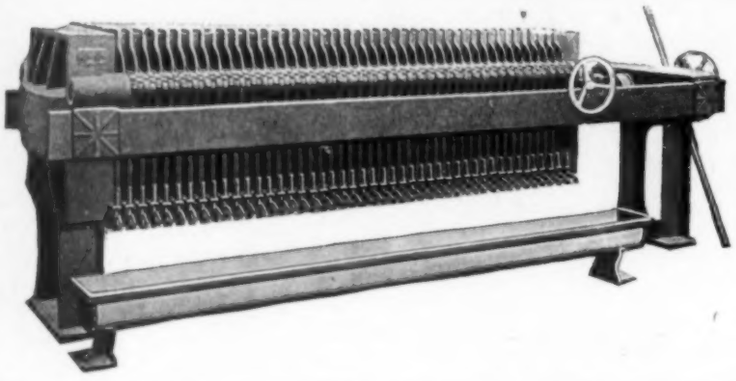

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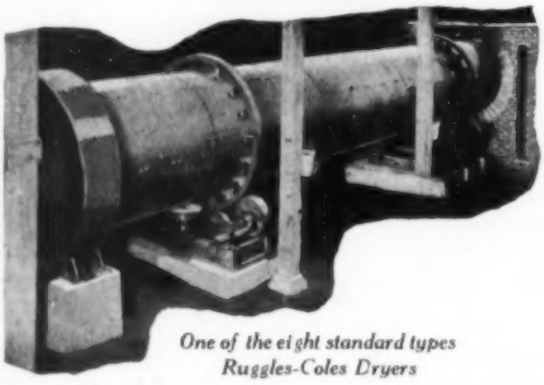

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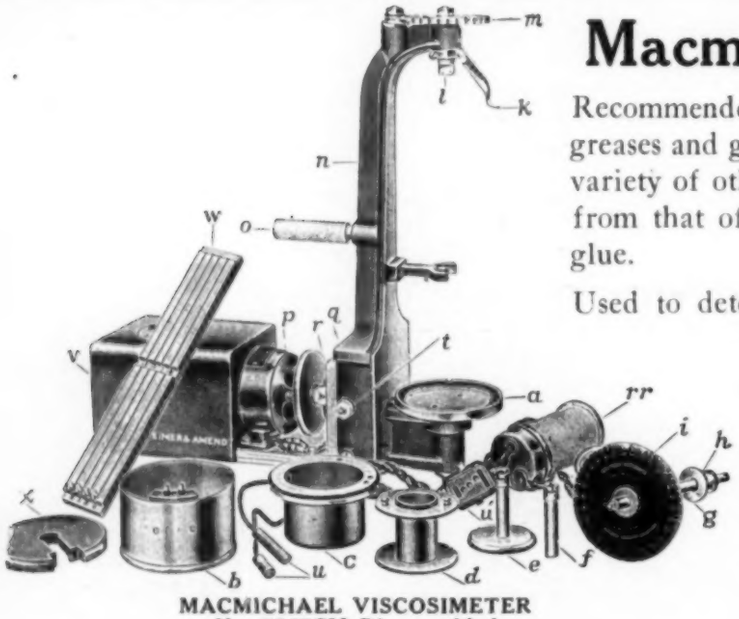

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Conferences and Publicity On Unemployment

HOOVER'S bent for organization was in evidence when the unemployment conference gathered, setting a mark which the meeting on disarmament will find difficulty in hitting. The invited conferees found the mechanical details had been well arranged; adequate rooms, stenographic and clerical service were in waiting. Not only that, but a tentative plan of organization and procedure had been prepared, a plan which was under discussion by a special committee within an hour after President HARDING had delivered his opening address. By 3 o'clock the committee's report had been considered, the main body had resolved itself into smaller units and each was working on some phase of the unemployment situation, using as raw material a mass of facts, records and statistics gathered during the preceding weeks by qualified investigators.

With such a flying start, an emergency program was reported on October 1, five days ahead of the tentative schedule, and final meeting of the general conference will occur on October 10, when a permanent program will be considered.

New and brilliant ideas can scarcely be expected from this meeting—no panacea short of a millennium will cure the various ills afflicting the nations of this earth. But even the emergency program should result in vigorous and widespread propaganda, calling on every one to aid according to his circumstances and ability. Construction by governments and municipalities can be broadened by each establishment and even each property owner going ahead with needed repairs and renewals. A tremendous amount of unemployment will disappear when adequate steps to relieve the housing shortage are taken. Furthermore, if manufacturers, all manner of middlemen and retailers would think more on production and distribution with the greatest expedition and minimum waste rather than with the greatest profit, reasonable prices to the ultimate consumer would again obtain, and the buyers' strike vanish into thin air.

Exorcising profiteers with the fair name of patriotism is a waste of breath. Adequate publicity on unemployment, however, will stress the fact, and perhaps blast its way into consciousness, that "bare shelves" in Germany cannot be filled by us as long as marks are not worth a cent; that times will therefore be good in the United States only if domestic trade is thriving; that "unsatisfied consumer demand" in America has less and less chance of becoming satisfied as long as unemployment and low prices on raw materials, coupled with high retail prices, combine to prevent purchases by the men and women who must work for their living. If foreigners cannot buy, we must depend on our neighbors. But if the farmer gets next to nothing for his hides, and the longshoreman has no work, how can either of them buy $10 shoes?

Anent Peace With Germany

ON THE DAY the treaty of peace was signed between the United States and Germany they had a great meeting in Berlin. Thirty thousand persons participated, and their leaders were Prince EITEL FRITZ and General LUDENDORFF. The old regiments paraded and fair daughters of the Empire strewed flowers before them. The bands played "Die Wacht am Rhein." "Undefeated in the Field" was the slogan that floated over the stadium. "With proud gratitude," wrote the old Kaiser from Holland, "I think today of my brave comrades, never vanquished in the field," etc. We suppose he referred to those that did not run away as he did. What he said about the beacon for victorious illumination in the dark future was not very important, because whatever he says is not important. But the threat of his presence as a symbol is not to be despised. Count VON WALDERSEE said, "There will come again a day when we will stand together for Kaiser and for Fatherland. Hatred will stand guard in Germany. We must train our children to use the rifle and the sword." And he urged them to prepare for revenge, revenge for their present impotence.

Well, what is to be done about it? It behooves us to keep our tempers and think before we act. Fulminations at a mass meeting are not final and binding. We might hear a lot of dicta that we should hate to publish as public opinion by listening to soap-box orators, almost any evening, on the streets of New York or, for that matter, published in current journals.

We have always felt that it was a great error not to lick the Germans a little harder than we did—until they knew that they were licked. With two weeks more of chasing they would have been Kamarading it all over Europe wherever they could make themselves heard. They might have brought influence to bear on these orators of the other day to be more modest in their expressions. If we are to trade with Germany as a friendly nation, we want to know it. If we are to trade with a race of people who are resolved to destroy us for their own infamous aims of the past, it is well that we should know that too.

It is not fair to indict a whole people for what their rulers do. But if they persevere in selecting rulers who lead them astray they must take the consequences of going astray. Our business is to wait and observe. If they cannot govern themselves and if they establish a war-lord king again, then the less we have to do with them in the way of commitments and obligations the better it will be for us. It would be a great mistake to tie ourselves up with German industries once more so that we cannot get along without them. The wise course will be to keep other markets open and reasonably active, no matter what they offer and to make ourselves as self-sufficient and independent as humanly possible.

When Is a Research A Mere Inquiry?

ARE we not, many of us, often guilty of loose talking when we talk about research?—guilty of calling researches things which are often nothing more than systematic tests? A real researcher is as jealous of his proud calling as an engineer, and, like the latter, must rebel at times against the lack of precision which associates several different branches of human endeavor with his calling.

These thoughts were called to mind at a session on Research at the recent meeting of the American Society for Steel Treating, addressed by no less personages than E. P. HYDE, Director of Research at Nela Park; COMFORT A. ADAMS and H. E. HOWE, of the National Research Council; A. E. WHITE, Director of Engineering Research, University of Michigan; and GEORGE K. BURGESS, of the Bureau of Standards. Dr. HYDE opened the way to a blanket discussion by presenting and elaborating the following interesting outline:

RESEARCH
- (*A*) SCIENTIFIC
  - (*a*) *Pure Scientific Research*
    - (1) Frontier research. (Best performed at universities and privately endowed laboratories.)
    - (2) Intensive and co-operative research. (Best performed by governmental, endowed or corporation laboratories.)
  - (*b*) *Applied Scientific Research*
    - (3) Industrial research. (Best performed in corporation and private laboratories.)
- (*B*) ENGINEERING
  - (4) Engineering research. (Best performed by the government, corporations, technical school and private laboratories.)
  - (5) Engineering practice. (Best performed in corporation and private consulting laboratories.)

These five classes cover a wide range. Even though dictionary definitions may be discovered that show "research" to include them all, we protest that it is too much. Item No. 1 doubtless is RESEARCH, resulting in the discovery of a new and unknown fact. No. 2 takes this fact and proceeds to an EXAMINATION of it from all angles. No. 3 devises APPLICATION of the new truth to human comfort; No. 4 is often nothing more than TESTING of materials, and the last is usually mere EXPERIMENTATION.

Research is often, and with reason, likened to a *voyage of discovery*, out into the unknown country. Land once discovered, then comes the task of *map making*, followed by necessary *road building*. Next comes an era when the *fields are cultivated* or other natural resources exploited, and lastly, when the land has been well settled, comes the necessity for *crop rotation* and fertilization. These phases in the development of a new land roughly correspond to the five classes of "research" listed by Dr. HYDE; and we submit that it is a far cry from the trackless forest to the truck garden.

Or, drawing another rough parallel between the kind of men who do the investigative work and the men who develop a country, first we have the EXPLORERS who push out into the jungle; then come the PIONEERS entering the wilds. After them follow CAPITALISTS building up industries demanding the services of ARTISANS, and finally are acquired PRODUCTION ENGINEERS! Even allowing for a certain freedom in this characterization, surely there are profound differences in the mental and spiritual equipment of these five classes of men.

So, we repeat, let us be a little more careful in our use of terms. We instinctively place the title "sales metallurgist" in the Index Expurgatorius. Let us be as circumspect in calling a research a few experiments yielding a few approximations of certain physical properties of something or other. The work may unquestionably be worth while; but it is not research, nor is it done by a researcher.

Student Chapters For the A.I.C.E.

ONE of the questions awaiting final decision by the American Institute of Chemical Engineers at its coming meeting in Baltimore is the proposal to establish student chapters of the Institute. At Detroit, last June, the matter was reported favorably to the council, but the amendment to the constitution, in its final form, is yet to be approved. In taking this step the Institute is following the example set by several of the other engineering societies. The American Society of Mechanical Engineers now has fifty-eight student branches representing institutions located in thirty-one different states. The American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Institute of Electrical Engineers and the American Ceramic Society have provided for affiliated student societies, and it would appear that these branches have been mutually beneficial—both to the students themselves and to the members of the parent societies.

Probably the most obvious advantages are to the student. Contact with the professional organization stimulates the student's interest in his chosen field. The privilege of attending the society meetings brings with it the opportunity for social intercourse with the older members and the benefit of their advice and council. The meetings of the student chapters also develop the student's ability to present technical papers before an audience—and it is evident that many of the more seasoned engineers show the need for such practice. And finally, in the case of some of the societies, the student is given the expectation of some day becoming eligible to junior, associate or active membership.

The mother organization, too, is forwarding its own interests by this early introduction of the engineering student to the purposes and functions of the society. The men in the colleges today are the men in the industries tomorrow, and it is worth while for the societies to keep in touch with them and to follow their progress. Furthermore, by furnishing speakers and councilors to the student chapters the society is carrying on a great educational work for the profession which it represents. The colleges and universities, in turn, are benefited by the *esprit de corps* fostered among the students. The better realization of future responsibilities makes for a more serious purpose on the part of the student, and this should be reflected in the scholastic standing of the institution.

All of these worth-while purposes can be accomplished in the field of chemical engineering. The indefinite status of the chemical engineer in some institutions and the continual jostling back and forth between the chemists and the engineers, with recognition by neither, has resulted in an unhappy situation for the student in chemical engineering. If, however, he can become affiliated with a professional organization of the character and recognized standing of the Institute and if, for his guidance, he can look to its members and their accomplishments in the chemical industry, his status will have been improved materially.

The Dye Industry And Modern Warfare

THERE is a book lately published by Dutton & Co. which we propose to review at length some day when time is less pressing, called "The Manhood of Humanity, or Human Engineering," by Count ALFRED KORZYBSKI. It brings out the fact that we have passed the childhood of Humanity, and are now grown up. We may like our old toys and our childish ways, but we know better. For the first time in literature as we know it a definite answer is given to the question, "What is man?" The book is a work of amazing enlightenment.

The opening of the Chemical Exposition brought the idea to mind. We are grown up. Senator LENROOT and General FRIES both called attention to the immense significance of chemical warfare. "We have entered into a treaty of peace with Germany," said the Senator, "and her battleships are sunk and her army disbanded. But her greatest stronghold remains. Her great arsenals of chemical warfare are unimpaired." It is fair to say that Germany today is the strongest military power on earth because *warfare has changed*. We may not like it, but that does not alter the fact. We remember the flare and the dash and the grand appearance of cavalry troops, but of what value are they really? A battalion of well-trained chemical warfare troops can put a whole division of cavalry out of business. General FRIES spoke of the sinking of warships by bombs dropped from the air, and called attention to the fact that this was done without the aid of smoke. If the warship that was sunk had been manned by an enemy crew a dose of smoke would have put all their air defenses out of business, while explosive bombing would have sunk her. Warfare has changed, both on sea and on land; and warfare in the air has been added. General FRIES also declared that without an active and progressive chemical industry engaged in intensive organic synthesis over a broad field, of which the dye industry is but one branch, a nation is without military defense.

Senator LENROOT said we may agree on limitations of armament and war materials as much as we please, but we must not agree to any limitation of scientific activity. We must not agree to prevent our scientists from working for national defense, and he earnestly hoped that the country will recognize the need of this.

General FRIES reminded the audience that not one new chemical was used in the late war. Everything used was known before. Making mustard gas, for instance, was a slow process until Sir WILLIAM POPE invented the new and rapid one which was eventually put to use. But even by the slow process the Germans *had the facilities* in their dye-works, and it is reported now that a new indigo technique lends itself by a slight transformation to the production of mustard gas. He joined Senator LENROOT in the willingness to enter into any agreement as to limitation of defenses and armament, but said that the last thing on earth to do is to agree not to use chemical warfare on an attacking enemy.

There is a powerful lot of thinking to be done these days. And in the face of the fact that the old order is not only changing but has changed already, we lose all safety in conservatism. We must seek our welfare in understanding and in wisdom. And we must not forget that chemistry can do.

"Normalcy" and Extrapolation

WE HAVE HEARD so much lately about "returning to normalcy" that the word has become somewhat nauseous to quite a few. Sometimes we have to deal with unpleasant expressions just as we must deal frequently with unpleasant things. Undoubtedly the idea is all right, and if the thing still has to be talked about, it is because the operation has not been completed.

Now the word "normal" may be used in connection with various things, such as a state of mind, a rate of doing work and a volume of business. If we think of "normal" in connection with a state of mind, we mean simply a sensible, reasonable, rational state of mind. There is no room for argument there. All of us should be that way. Usually or frequently we are not, so "normal" in that case scarcely means "natural" and it is not even interchangeable with "average."

Dismissing the concept of "normalcy" in connection with a state of mind as being something we cannot disagree upon, one observes the desire to judge business affairs by reference to "normal," and it is plain that very often this requires extrapolation. When a period of time has passed it is not difficult to decide what was normal during that period, but we are always at the center of time. The past is behind us, the future before us. Hence we must extrapolate.

The problem is really to determine when to extrapolate and when not to extrapolate. We see many references to "pre-war prices." That is far from extrapolation, since such statements refer to a period ended seven years ago. When we consider quantities of business, on the other hand, nearly everyone is disposed to extrapolate. We expect expansion and increase. Normal today is not the average of past years, but the average of past years plus future years.

Now in extrapolation we can easily make serious mistakes. For instance, the production of coal was 219,976,267 tons in 1898 and 357,356,416 tons in 1903. That represented an annual rate of increase of 10.2 per cent, equal to a doubling in a trifle over seven years. If at the end of 1903 one had extrapolated to 1922 he would have found 2,259,000,000 tons as the proper production for next year. This year's production is expected to be about 425,000,000 tons. To follow the rule, next year's production should be five times as much, not to speak of making up for lost time. This is fanciful, and no one tries it, but substantially that sort of thing really has been argued as to pig iron. Men have taken the previous rate of increase, carried it forward, and computed the number of tons by which the world was deficient, insisting that the world would probably try to make it up, if not to regain the former pace.

Between returning to pre-war conditions and conditions indicated by extrapolation there is a very wide gap, and yet the proper applications of "normalcy" hit points all the way from the one extreme to the other. We want to be normally useful. We should think not of quantities of coal, but of useful results. The total quantity of coal produced has been increasing, but the quantity per unit of work, electric light thrown on the machine tool, or locomotive drawbar pull, has been decreasing. We should think less of the quantities that go into the statistics and more of the useful results attained, measuring success not by quantities of money or materials or hours employed but by useful work accomplished.

Readers' Views and Comments

Boiler Feed Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the article on "Boiler Feed Water Purification," which appeared in your issue of July 6, the author makes a number of interesting points whose correctness will be conceded by all specialists in industrial water purification. In his zeal, however, he makes several statements which probably would never have seen the light of publication had he been writing from a strictly impartial standpoint.

In a former capacity as chemist for one of the larger manufacturers of zeolite water softeners I have analyzed at various times the effluent from many zeolite water softeners; Permutit, Refinite, Borromite and De-Calso were all included. These analyses without exception have shown that Mr. Applebaum overstates his case very, very badly when he writes as follows: "Slight amounts of hardness in the effluent of some zeolite softeners have been noticed in some cases; but this can mean only that the particular zeolite softeners examined were improperly designed and that the volume of a proper grade of zeolite used was not in sufficient excess so that the softener was seriously overloaded. . . . If the size of the zeolite softener is correctly selected to take care of the required volume of water containing a known hardness, the effluent of the softener is always of zero hardness."

It is obviously impossible that these statements could be correct, except by taking the meaning given by the zeolite manufacturers themselves to the term "water of zero hardness." As I understand it that meaning is: Any water which, titrated against standard soap solution, produces a permanent lather with an amount of soap solution representing 1.4 grains per gal. or less of hardness, expressed in terms of $CaCO_3$. The very law which makes zeolite water softening a commercial possibility—the law of mass action (which is but a phase of the law of ion concentration)—renders it impossible to remove entirely all Ca and Mg from natural supplies of water. On account of this law, whereby the excess of the sodium in the zeolite forces an exchange for the Ca and Mg in the water, waters having a high sodium content cannot be successfully treated, for the exchange ceases where the point of equilibrium is reached between the sodium in the zeolite and that in the water. In waters of low sodium content, the exchange can progress much nearer completion, but the point of equilibrium is nevertheless reached before the Ca and Mg have been entirely eliminated from the water. When this point of equilibrium is reached, were we to add a slight—a *very* slight—amount of some sodium salt to the water, the equilibrium being disturbed, a reverse reaction would take place, until the equilibrium was restored.

In an article which appeared several months ago[1] the writer quoted an analysis of a representative zeolite-treated water, the hardness of which expressed in terms of $CaCO_3$ was 0.50 grain per gal. (This, incidentally, is as nearly free from Ca and Mg as has been any sample of zeolite-treated water which I have analyzed.) This is the analysis to which Mr. Applebaum refers in the paragraph quoted above. It is possible that he may have been misled by a typographical error, corrected in a later issue, whereby the $CaCO_3$ equivalent hardness of this zeolite-treated water was given as 6.50 grains per gal., but an examination of either the context or of the analysis itself should have corrected any such false impression, for the analysis showed $CaCO_3$ 0.25 grain per gal. and $MgCO_3$, 0.21 grain per gal.

He also makes the following assertion: "It is falsely claimed that zeolite-softened water increases the tendency of boilers to foam, on the consideration that the sodium salts have a heavier molecular weight by about 5 per cent than the corresponding calcium or magnesium salts."

This appears to be a misinterpretation of point 1 in the discussion of the disadvantages of the zeolite system of water purification in the article mentioned above.[2] The unquestioned tendency of zeolite-treated waters to foam should not be attributed to a difference in molecular weight. The cause for this increased tendency is the increased amount of sodium salts in the water, the Ca and Mg being replaced by sodium, and sodium salts being notorious offenders in causing foaming, a property almost entirely absent from Ca and Mg salts.

Furthermore, his chemical arithmetic is not accurate. In the average natural water, on account of the fact that the $CaCO_3$ is held in solution by half-bound CO_2, a quasi-bicarbonate, 1.00 grain per gal. of $CaCO_3$ is not replaced by 1.06 grains per gal. of Na_2CO_3, but rather by 1.68 grains per gal. of $NaHCO_3$; and 0.84 grain per gal. of $MgCO_3$ is replaced by 1.68 grains per gal. $NaHCO_3$; exactly double the amount. Take, for example, a water whose analysis showed 10.00 grains per gal. $CaCO_3$, 8.40 grains per gal. $MgCO_3$ and 2.60 grains per gal. of sodium salts—total, 20.00 grains per gal. Ignoring the small amount of Ca and Mg salts which would remain unchanged, the zeolite-treated water would show 33.60 grains per gal. $NaHCO_3$, 2.60 grains per gal. of other sodium salts, a total of 36.20 grains per gal. of sodium salts where there originally was only 2.60 grains per gal. This is the basis of the claim which Mr. Applebaum brands as false.

And, as is well known, the carbonates are the most notorious of all sodium salts in causing foaming, not to mention that when introduced into the modern high-pressure boiler they have been known to break up, forming volatile organic acids which have caused destructive corrosion in pipe lines and in steam-consuming equipment.[3]

There are a number of other points in the article which are not compatible with the writer's experience in the purification of water for boiler feed, notably those concerning the baking of sludge in the boiler, where his contention is impossible without criminal negligence in blowing down, on account of the levigating

[1] "A Comparison of Various Methods of Water Purification," CHEM. & MET. ENG., vol. 24, No. 3, Jan. 19, 1921, p. 123.

[2] *Loc. cit.*, p. 126.

[3] "Boiler Chemistry and Feed Water Supplies," J. H. Paul, published by Longmans, Green & Co., Chapter X.

effect of the racing circulation of the water in the boiler; the fact that he exaggerates the disadvantages of boiler compounds, thereby attaching to these disadvantages greater weight than they possess; and he denies the existence of certain advantages which an impartial steam expert will concede to them; and the fact that he minimizes the importance of the disadvantages which practical experience has taught are impossible of elimination in the use of the zeolite system in treating water for boiler feed.

It is really regrettable that an article of so much unquestioned merit should have contained these few glaring discrepancies; and after attempting to correct them, I wish to congratulate Mr. Applebaum upon an article which was highly interesting and genuinely instructive.

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The Slip Interference Theory of the Hardening of Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—The complete solution of the difficult problem of the hardening of metals cannot be very far off now. In the recently published paper[1] by Jeffries and Archer mentioned above the authors in a very meritorious way drew up the principal lines that undoubtedly must be followed to a clear conception of the phenomena of hardening.

The question is very important and has been dealt with in a scientific manner as long as there has been theoretical metallurgy. Jeffries and Archer do not give any account of previous investigations on the matter. Surely it would have been a difficult enterprise to give a lucid review of the many developments in this field of research, considering the great number of rather obscure speculations and theories put forth in the course of time on this matter. However, by reviewing former researches the authors should certainly have found that ideas similar to their own have been suggested before, even if the hypotheses have not been nearly as fully comprehended and ably presented as in this new paper.

F. C. Thompson[2] in 1916 drew the attention to the disturbing effect that atoms of a substance in solution certainly have on the space-lattice of a metal. He was also well aware of the influence of this distortion on the hardness of the solid solution, even if he ascribes the hardness to those rather problematic and unproved internal stresses in the metal—stresses about which there has been so much written.

Another very clear conception of the great importance of the influence of foreign atoms in a space-lattice has been put forth by C. Benedicks[3] in 1916. Possibly Jeffries and Archer are not familiar with this contribution, as it is part of a paper concerning metallic conduction of electricity. To show how very similar the ideas of the American authors are to those of Benedicks a paragraph may be quoted from page 390, on the hardness of martensite:

"This enormous influence on hardening can evidently be accounted for, even if the phenomena of allotropy are taken into consideration, if we might suppose that one single foreign atom has the power to lower the possibility of sliding displacements and to act like a 'key' for whole planes (like a grain of sand on a rubbing surface in a machine)."

A few weeks ago a very interesting article on the hardness of solid solutions has also been published by W. Rosenhain,[4] who on the whole has the same views on this matter as Jeffries and Archer.

The reason why former attempts to solve the hardening problem have not been successful may probably be attributed to the fact that the phase rule hitherto has been such a dazzling loadstar to metallography. Investigators on this research field have been so accustomed to the habit of thinking in diagrams that they have not paid sufficient attention to the fact that the various phases are built up of a manifold number of crystals, every one with a certain architecture of atoms.

In the first decade of this century the real existence of atoms has been proved. In the following years it was shown by Laue and Braggs that the atoms in crystals are arranged in regular space-lattices. Problems covering the internal structure of crystals have come into the focus of scientific interest, thinking in terms of diagrams by metallographers begins to give place and will yield still more to thinking in terms of atoms.

Jeffries and Archer have certainly been led to their conception of hardening by their dealing with X-ray analysis of metallic phases. I have also made some X-ray spectrographic investigations of metals[5] and have come to the same conclusions regarding the hardness of solid solutions as they. In principle I completely agree with them. In a few points, however, my opinion differs from their views.

I do not think the reasons presented for saying that carbon in martensite is dispersed in the form of atoms are quite convincing. I am more inclined to believe that martensite really contains cementite in the form of Fe_3C molecules, and even as very small Fe_3C crystalline grains. The chief reason that Jeffries and Archer put forth for their assumption is that it is impossible for carbon atoms to migrate freely in the metal if they are in contact with particular iron atoms. The authors have evidently overlooked the fact that each carbon atom can very well be connected with three iron atoms and yet easily travel in the metal, since during the displacement it merely changes its companions. If one supposes that there is Fe_3C present in martensite, the very great hardness of martensite as compared with austenite follows in a very natural way. Molecules or grains of Fe_3C certainly act as more efficacious keys, producing slip interference in the ferrite crystals, than could free carbon atoms. I do not wish to go deeper into this matter now; the question can be further elucidated experimentally.

Indeed there are still other points that I would like to discuss with the American authors, such as the influence of amorphous metal, which I think has been very much exaggerated, but it would be better to wait for experiments to decide whether my opinion is right.

Last, I wish to congratulate Dr. Jeffries and Mr. Archer most heartily upon their excellent paper and to record my very firm conviction that a final solution of the hardening problem certainly will diverge very little from the assumption given therein.

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Metallografiska Institutet,
Stockholm, Sweden.

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[2] *Trans.* Faraday Soc., vol. 12, June, 1917, p. 23.
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[4] *Proc. Roy. Soc.*, A, vol. 99, 1921, p. 796. Reprinted in CHEM. & MET. ENG., vol. 25, p. 243 (Aug. 10, 1921).
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Meeting of the American Society for Steel Treating

Varied Social and Technical Activities at the Indianapolis Convention — Some Important Papers on Carbonizing, Heat-Treatment of Ordnance, Manufacture and Properties of Tool Steel, and Theory of Hardening, Abstracted From a Great Wealth of Material

INDIANAPOLIS royally entertained the third annual convention of the American Society for Steel Treating during the week of Sept. 19. In fact, if any criticism should be leveled against the local members of the society it was that they entertained somewhat too lavishly. Mr. and Mrs. George Desautels, acting as chairmen of the members' and ladies' entertainment committees, certainly spared no effort and scarcely left breathing time for their guests. In addition to the usual smoker and banquet, auto trips, teas and such familiar events, the Steel Treaters and their friends—numbering in all some thousands—beheld a special race on the Indianapolis Speedway, certainly something which only Indianapolis could produce. Ten or a dozen "speed kings," whose names doubtless would be very familiar to racing fans, donned their goggles and helmets and thundered around the track at 100 miles an hour. It was a real Roman holiday and furnished even the exquisite thrill of a car running wild over the top of the embankment, crashing double fences into kindling wood and furnishing the surgical ward with two more patients.

Membership and Financial Status—New Officers

Prof. A. E. White, of the University of Michigan, the retiring president, called attention to the fact that the present membership is 3,237, an increase of approximately 500, or 18 per cent, in the past year. Local chapters also increased by four, the present number being thirty-one. Financially the society is in excellent shape, having no unpaid obligations whatever, while the cash on hand was increased about $6,000.

F. P. Gilligan, of the Henry Souther Engineering Co., Hartford, Conn., was elected president of the American Society for Steel Treating for the year 1921-22. F. C. Lau and R. J. Allen are the new vice-presidents, J. V. Emmons the treasurer, while W. H. Eisenman retains the post of secretary.

One of the features of the Steel Treaters' conventions is the daily conferences between national officers and the representatives from each of the local organizations, or "chapters" so called. Many phases of the society's affairs are discussed, with the view of making a determined effort to shape this organization's activities in the correct way. It has made great progress already, and it is not too old to learn.

The exhibits of steel-treating equipment were held in the Manufactures Building at the State Fair Grounds and the technical meetings in the Women's Building, just alongside. In view of the business depression the displays on the whole were not very elaborate, but sixty different concerns manufacturing furnaces, pyrometers, tool steels, carbonizing equipment and heat-treating accessories were represented. Transportation between downtown hotels and somewhat distant Fair Grounds was adequately handled. The attendance was good, especially at the technical sessions. These were twelve in number, at which no less than eighty-two papers on various phases of metallurgy and metallurgical equipment were presented, either in whole or by title. Printed abstracts of all of them were available, however. A very unusual amount of interest was displayed at these meetings, but the crowded program prevented much discussion. A number of papers are abstracted in these columns. Unfortunately, however, manuscripts of some very important contributions were not available, but they will be printed at length in the society's monthly *Transactions*.

Session on Case-Hardening

The convention opened its technical sessions on Tuesday with a number of interesting and valuable papers on carburizing.

S. C. Spaulding, metallurgist for the Halcomb Steel Co., Syracuse, N. Y., first presented the voluminous results of a research on the comparative rate of carbon penetration in various commercial steels whose chemical analyses are listed:

Group	Alloy	Alloy Content	Carbon
1	Cold-rolled	.....	0.15
	Hot-rolled	.....	0.20
2	Cr:Si:Mn	0.83 : 0.31 : 0.78	0.16
	Cr:V	0.92 : 0.17	0.17
3	3½ per cent Ni	3.5	0.16
	5 per cent Ni	5.29	0.14
4	Cr:Ni	0.98 : 3.14	0.18
	Cr:Ni	1.31 : 3.79	0.11
5	Cr:Mo	0.96 : 0.48	0.13

Three-fourths-in. rods were turned, and one specimen of each was packed in a single box, using a commercial carbonizer. A dozen or more such boxes were put into a large furnace, brought to 1,600 deg. F., and a pair of them removed after 5 hours, 10 hours, and so on up to 60 hours. A second run was made at 1,700 deg. F. After cooling in the pots a wafer was cut from one end, split, polished, and the depth of case measured by microscope, estimating distances to the place where carbon was 0.50 per cent. Typical results follow:

	Penetration			
Time,	0.15 C		3½ per Cent Ni	
Hr.	1,600 Deg. F.	1,700 Deg. F.	1,600 Deg. F.	1,700 Deg. F.
5	0.019	0.029	0.022	0.037
15	0.039	0.052	0.052	0.070
30	0.053	0.075	0.077	0.096
50	0.060	0.095	0.092	0.111
	First Cr:Ni		Cr:V	
	1,600 Deg. F.	1,700 Deg. F.	1,600 Deg. F.	1,700 Deg. F.
5	0.023	0.040	0.023	0.041
15	0.058	0.089	0.051	0.072
30	0.090	0.131	0.075	0.100
50	0.111	0.150	0.086	0.107

Results on penetration and microstructure can be grouped as shown in the first table.

Group 1. Both carbon steels gave time: penetration curves of exactly the same shape, the cases in the hot-rolled being somewhat deeper probably owing to its much lower phosphorus. A cementite network appeared at the edge, inclosing very large grains of pearlite; then a zone of pearlite, then carbon decreasing to the original stock.

Group 2. These curves were about the same up to 40 hours. It seems that 0.17 per cent V, which is the only material difference, had no effect on carbonization. Cementite appeared as rounded masses—there was no network or large grain growth.

Group 3. Nickel retards cementation; this is especially noticeable in the 5 per cent Ni sample. The 3½ per cent Ni sample showed a fine lacy network at the edge, the cementite accumulating into small spots after being carburized a long time at 1,700 deg. F. No network was observable in the 5 per cent Ni sample. The original material possessed a very pronounced banded structure characteristic of many rolled products, and the carbon penetration favored certain of these bands very markedly.

Group 4. This combination, chromium:nickel, seems to be of unique benefit to carbonizing, and these samples gave the deepest cases. They are air-hardening, and the outer edge was austenitic, containing excess carbide as large patches at the border. As the carbon decreased, the ground mass became martensitic, troostitic, and on down. The case preserved the banded structure very clearly; high-carbon bands appeared to replace the original low-carbon streaks.

Group 5. This steel was run at a different time, using the Cr:V of group 2 as a check. Cr:Mo gives slightly deeper penetration than Cr:V, but is associated with a wide cementite network containing many sizable accumulations of carbide. No banded structure remained of this very pronounced condition in the original metal.

Each of these steels was given the appropriate single and double treatment recommended by the S.A.E. specifications, furnishing a mass of data not easily compressed. In general, however, the alloy steels are more easily refined than carbon steels in a single treatment, and give better microstructures after the double treatments.

Wood Charcoal as Carbonizer

Although wood charcoal is not looked upon with favor as an agent for case-hardening, H. Schagrin, chief chemist of the U. S. N. Ordnance Plant, Charleston, W. Va., described a commercial operation where it had proved very satisfactory. The parts hardened were forgings about 12 in. long made from acid bessemer steel analyzing C 0.15, Mn 0.70, S 0.05, P 0.06, forgings cheaply made and requiring cheap treatment. Unscreened charcoal up to 30 mesh was used, attempting to place 1 in. of the material between pieces, the cover pressed down and luted, exactly as in ordinary practice. Three of the boxes in each furnace load contained thermocouples, and one of them a "spy" which the furnace tender could withdraw and judge the heat visually.

On being drawn it was often found that one-quarter of the charcoal had burned, due to infiltration of air, but very seldom did this spoil the bright silvery color on the metal. An hour and a half at 1,900 deg. F. gives good carbon penetration to a depth of ☆ in., each 50 degrees above this point makes a great difference in the depth and character of the case. Experimentally it was found that a carbonization in wood charcoal must be performed at above 1,750 deg. F. or no appreciable result will occur in a few hours' time. The charcoal was forked and re-used, although its consumption was heavy.

For conditions as existing at that plant—i.e., a mass of cheap parts to be given a thin case, with carbon no higher than 1 per cent—the author would recommend wood charcoal as a cement, allowing 1½ to 2 hours at 1,900 or 1,925 deg. F. Two runs can easily be made per shift.

Hardening With Cyanamide

Prof. Richards read a paper on the Shimer Case-Hardening Process before the 1919 winter meeting of the Mining and Metallurgical Engineers. The inventors now give some further data on its operation, as perfected by five years' experience. It may be remembered that a bath of $CaCl_2$ and NaCl (known as "Meltite") is first prepared, and first-class, hard cyanamide (known as "Cyrok") immersed by a weighted basket. Soon a rapid evolution of gases occurs, bursting into small yellow candle flames at the surface of the pot, this continuing for some hours—as long as the bath is active, when, of course, new cyanamide must be added. The gases analyze 70 to 80 per cent N_2 and the remainder CO plus a little CO_2. No CN has been found by analysis, nor is there any cyanide odor noticeable.

Cyanamide air-slakes, and the fine material must be carefully removed in order to prevent frothing in the bath. It should also be handled with gloves. "Meltite" is also hydroscopic, and must be stored in tight cans. It melts at 1,150 deg. F., and while the usual operating temperature is 1,425 to 1,450, it can be heated to 1,700 deg. F. without unusual volatilization. At the latter temperature it produces a ☆-in. case in 2 hours.

It is necessary to dip the finished metal in hot soda ash solution, since any speck of $CaCl_2$ remaining will facilitate corrosion.

Comparative carburizations in cyanamide and cyanide have been made, and it is found that the former consistently puts higher carbon and lower nitrogen into the metal. For instance, a steel containing C 0.09, Si 0.18, S 0.04, P 0.01, Mn 0.40 was case-hardened 1 hour at 1,526 deg. F. (830 deg. C.) and analyzed with the following result:

	—Cyanamide—		— Cyanide —	
	C	N	C	N
1st cut 1/200 in.	0.75	0.30	0.62	0.35
2nd cut 1/100 in.	0.24	0.04	0.27	0.08
3rd cut 1/100 in.	0.16	0.04	0.11	0.03

Cyanide Hardening

Observations on the time of penetration in three different cyanide baths were made by V. E. Hillman, metallurgist of the Crompton & Knowles Loom Works, Worcester, Mass. The process is ordinarily used to give a very hard thin case on pieces made on screw machines. Ordinarily a mixture of about 27 per cent NaCN, 18 per cent NaCl and 55 per cent Na_2CO_3 is used, the latter two raising the melting point of the mixture, and thus conteracting the loss in speed of work due to low concentration of the active cyanogen. The more concentrated cyanide baths must be run at a considerably lower temperature.

A quenched case is composed of two distinct rings; the outer one of martensite and a narrow inner one of

troostite; the center of the latter was taken as the depth of penetration. Results follow:

Time, Minutes	Penetration in Inches: 27 per Cent NaCN at 1,475 Deg. F.	76 per Cent NaCN at 1,425 Deg. F.	98 per Cent NaCN at 1,375 Deg. F.
5	0.010	0.010	0.015
10	0.015	0.016	0.020
20	0.025	0.026	0.030
35	0.044	0.039	0.044
50	0.060	0.054	0.056
75	0.077	0.071	0.065
100	0.087	0.084	0.071
125	0.095	0.093	0.077
150	0.104	0.104	0.083
180	0.113	0.123	0.098

Heat-Treatment of Ordnance

Commander W. F. Leary, U. S. N., presented an interesting paper on the heat-treatment of steel for ordnance purposes, in which he ascribed a great part of the improvement in guns, armor and projectiles to the deve'opment of proper heat-treatment. Whereas it was formerly necessary to rely on the skill of the workmen, it is now recognized that sound ingots, preliminary annealing, prevention of grain growth after forging and preliminary machinery before forging are essential to prevent failures during heat-treatment. Recording pyrometers and all the ordinary precautions of heat-treating are now liberally used, and a definite and minute program of operation is studied and laid down in advance. Without this practice the 16-in., 50-caliber gun would have been impossible.

Ordinarily, specifications list the physical and chemical requirements in detail and only general notes on heat-treating designed to prevent gross mishandling. Shock tests should also be added, since the finished material before acceptance is tested severely, often by methods developing severe impact.

Castings of plain carbon and nickel steel are much used. Close inspection during manufacture prevents acceptance of pieces with blow-holes and other flaws and also insures correct melting practice for material which will heat-treat properly. Test coupons must be cut from the body of the casting itself to be of real value.

Specifications for gun forgings fill a small book. Numerous paragraphs cover raw materials, melting and ingot practice, so that it would be relatively easy to heat-treat to pass the physical tests. While the process is not specified, the acid open hearth and electric furnaces seem to give the surest results. Sulphur, phosphorus and copper maximums are the only chemical requirements. Physical requirements are between the following limits:

Tensile strength	86,000 lb. per sq.in.	95,000 lb. per sq.in.
Elastic limit (by extensometer)	46,000 lb. per sq.in.	65,000 lb. per sq.in.
Elongation	18 per cent	18 per cent
Reduction in area	30 per cent	30 per cent

These limits are very easy to meet in small pieces, but very difficult in forgings weighing tons. Four transverse test specimens are slotted out of each end, to cover outer, middle and inner portions; in case of failure a check test-piece is taken from that vicinity. Repeated failures cause rejection of the forging. Ghost lines and other segregations are usually associated with irregularity in test results, although it is improper to say that static tension or bend indicates that a ghost-line structure is itself detrimental.

Streaks or ghost lines are generally surrounded by good metal, and the factor of safety in the design is so large that in the case of large forgings their specific effect is greatly masked and difficult of appraisal. Many rejections, however, have resulted from this cause, because such flaws are considered evidence of the doubtful value of a forging. Ghosts are of two classes, one with fine sorbitic grains and much ferrite, the other with large sorbitic grains and absence of ferrite. Inclusions (probably manganese sulphide and silicate) may often be seen with the naked eye in these streaks —close microscopic examination always show them. If they are segregated, the metal is highly suspicious. It is now thought that minute specks of iron oxide are most detrimental to the steel; these, settling in the ferrite boundaries, weaken the adhesion.

Reduction in forging is at least half. The reduced bars are then usually given a preliminary anneal above Ac_3 (cooled in the furnace to 600 deg. F.) and an examination to insure a normal uniform structure. Rough machining removes that metal which shows no ferrite at grain boundaries, and the desired properties may generally be obtained by a simple quench and draw. A second and higher draw may be necessary if the test specimens show a uniformly great hardness. Structure is generally sorbitic, with grain boundaries plainly marked with uniformly distributed ferrite, considerably increased in amount toward the center. Sometimes needles of ferrite penetrate the grains along a geometric pattern; while this is not considered desirable, it is not reason for rejection. Successful metal can be bent 180 deg. flat without fracture.

Armor piercing projectiles of alloy steel are subjected to very extensive treatments, the details of which are held secret. Forging is done at a low temperature to prevent grain growth and a preliminary normalizing anneal given. After rough machining, the shell is given a series of oil quenchings and drawings for utmost grain refinement and production of "fiber." Hardening the point is done by a graduated heating by dipping the point in molten lead, and quenching in agitated cold water. The base is then reheated to a lower temperature, and suspended, nose down, in agitated cold water, thus tempering the rear only. The projectile point is covered with an alloy steel cap whose heat-treatment is similarly complex.

Forging and Heat-Treating at Watertown

F. C. Langenberg, director of laboratory and superintendent of foundry, Watertown Arsenal, explained the methods in use at that place. This work is of great variety, and includes much investigative work on new gun mounts and new high-strength forgings. Since these are all different, it is necessary that closest control be exercised, so that there may not be rejections of some important forging with consequent long delay, or doubt as to its exact history.

After the order for a certain job is received the engineering division makes the design, which of course involves selection of the strength and ductility figures. Then, after consultation with the foundry, metallurgical department, forge shop and machine shop, a forging sketch is prepared, showing the dimensions of the finished specimens, the dimensions after rough machining ready for heat-treatment, location of test specimens, and specifications for strength.

The planning division then routes the work, calling

upon the metallurgical division for information as to the size, weights and composition of the ingots required. If new ingots have to be made, they are ordered from the foundry, after a consultation with the foundry and metallurgical departments has determined the best chemical composition and melting and pouring practice. All of these steel-making operations, as well as the finished ingots, are inspected and carefully recorded by the metallurgical department. Inspection after forging is done by the inspection division; if defects are noted, they are reported to the metallurgist.

The accepted forging is then sent to the annealing department, and heat-treated exactly as specified by a chart of instructions. Then after machining to the heat-treating dimensions, and a second inspection, the forging is sent to the heat-treating shop, which has previously received all instructions as to the treatment desired on a drawing. This shows a complete time-temperature curve covering the entire treatment, and also the nature and temperature of the quenching medium.

The metallurgical division now makes the tests specified (these now include impact tests), and decides whether the piece is acceptable or whether a re-treatment is necessary. Then the inspection division makes its examination, and the accepted forging is shipped to its destination.

If trouble occurs anywhere between steel making and final loading, this close and continuous planning and inspection locates the blame quickly and precisely. Since each department foreman has been consulted regarding all features affecting his work, he is less apt to attempt shifting blame for poor results.

Carburizing Armor Plate

W. I. McInerney, of the Armor Plate Department, U. S. N. Ordnance Plant, Charleston, W. Va., presented a paper on the carbonizing of heavy forgings. The plate is forged somewhat thick, and replaced while hot to cool in an annealing furnace. All scale is removed from the plate, and any seams or surface imperfections are chipped out.

If only a thin case is required, say $\frac{1}{16}$ in., a plate is preheated to 1,500 deg. F., removed from the furnace, a 2-in. blanket of carburizer spread over, and the whole covered with a 3-in. layer of dry yellow clay (through $\frac{1}{4}$-in. mesh). The plate is then slid back into the furnace and heated for time and temperature known to give the desired results. Carburizers used for all this work are purchased (not home made) and must not burn off while being applied, flux with the clay or stick to the metal.

Heavy cases are made by heating plates in pairs, sandwich fashion, with 3 or 4 in. of carburizer between. The bottom plate will have an angle-iron frame attached around its edges, supporting a two-course brick wall to confine the granular material. Four pairs of such plates weighing up to 600 tons have been treated at one time in car-bottom furnaces 15 ft. wide and 52 ft. long. Such practice builds up the following cases in 0.28 C alloy plates:

Time, Hr.	Carbon at Depth			
	$\frac{1}{16}$ In.	$\frac{1}{2}$ In.	1 In.	$1\frac{1}{2}$ In.
24	0.90	.....	0.28	.....
120	0.96	0.59	.....	0.30
240	1.00	0.69	.....	0.35

Lighter sections (up to 5 in.) are often carburized while preheating for final forging. After having been raised to 1,500 deg. F. (requiring 12 hours), the piece is covered with carburizer, raised to the forging temperature (requiring 10 hours) allowed to soak for 24 to 30 hours. Carbon analyses resulting are at $\frac{1}{16}$ in. depth 0.90, $\frac{1}{8}$ in. 0.98, $\frac{1}{4}$ in. 0.80, $\frac{1}{2}$ in. 0.60, in a plate having C 0.50, Cr 2.10, Ni 3.50.

It is not usual to "fire back" the plate before stripping and after the completion of the carburizing treatment. Rather the furnace is stripped, and carburizer dumped. The heavy scale on the exposed surfaces falls off as the plate cools to about 1,500 deg. F. The whole plate is then covered with a protective layer of buckwheat coal, a layer of dry yellow clay, and heated for the final forging operation.

Tool Steel

M. H. Medwedeff, of Baltimore, Md., presented a short paper emphasizing correct hardening room practice—points which are well known, but often honored by their breach. It would be well to bear in mind at all times:

1. Anneal thoroughly before hardening, to remove any forging or machining strains. There is no short cut for this operation. Pack the tools in powdered charcoal, heat slowly to 1,500 deg. F., hold from 2 to 4 hours, depending upon the mass, and cool in the closed furnace.

2. Preheat the tool slowly, else exposed corners will be a long time at the high hardening temperature, with corresponding grain growth. In quantity work it is well to have three furnaces, one at 1,150 deg. F. kept filled and used as a stock furnace. Next is a furnace holding not more than three tools, kept at 1,525 deg. F. Next is the high temperature furnace (2,200 to 2,400 depending upon the steel) in which a single tool remains only a few minutes before being quenched.

3. Do not harden tools if you are color blind unless you use a first class optical pyrometer constantly. The thermocouple merely tells you the temperature of a particular spot in the furnace; color comparisons are the best way of judging whether the tool is as hot as the thermocouple.

American vs. English Crucible Practice

An extended paper by T. Holland Nelson, steel works manager of Henry Disston & Sons, Philadelphia, Pa., gave a detailed discussion of the crucible melting practice in England and America. Whereas abroad a simple coke hole is still used for 90 per cent of their tool steel and produces three rounds (since the war but two) of metal per day, here regenerative gas furnaces operate continuously, furnishing six heats per 24 hours. There they use fragile clay crucibles, costing 60c. each and good for a day's run, while here we use tougher and larger plumbago crucibles costing $5 each. Furnace output for a 12-hole furnace there amounts to 3,200 lb., while in America the production is 18,000 lb. Carbon variation in the clay crucible is quite small—it can be held as low as 0.06 per cent. Due to variable graphite consumption, steels from individual crucibles here vary as much as 0.30 per cent.

It is therefore necessary for Americans to teem all their pots into a mixing ladle, casting ingots from the latter. Thus a more uniform analysis is obtained. English steelmakers are as a rule still advocates of the advantage of hammering the ingot to a bar. This is done at a minimum temperature, and great care used to prevent surface decarbonization. Here we use rolling

mills almost exclusively, a practice which is not equal to the other, principally due to the fact that tonnage production seems to insist upon high rolling temperature and heavy drafts. Furthermore, English toolmakers still insist that the more Swedish iron they put in their crucibles the better the resulting steel—a contention the author unqualifiedly indorses, on the ground that no other known raw material is its equal.

Treatment of Tool Steel in the Mill

A. M. F. Green, chief of laboratory, the John Illingworth Steel Co., agreed with Mr. Nelson that hammering was much better than rolling for reducing high-speed steel from ingot to bar. Hammering is usually done in two heats; first the cogging, then the finishing. Both these operations are started at moderate temperature, the working continued in the first case nearly to Ar, while in the second heat light work may be continued at will to a lower temperature, thus producing more exact sizes and a stronger bar. The correct temperature may be determined by the gain in magnetism, or the greater adherence of scale below the transformation. Cooling from both hammerings is done in lime or ashes, so that a certain annealing effect results.

Rolling, on the other hand, is done from a single high heat, and the finishing temperature is less under control. Hot finishing results in large grains; high heats mean decarburized surfaces.

Normalizing, annealing, or both are necessary if the steel is to be shipped in the best condition. The former is especially necessary to break up banded structure in chromium steels. The correct structure is that in which complete spheroidization of the carbides has taken place. This is an extremely difficult thing to produce if the steel has a structure of great crystals such as caused by high temperature annealing or finishing. Veins of cementite making sorbitic grains in a piece of high-speed steel are indications of especially bad mill practice.

Tensile Strength of High-Speed Steel at High Temperatures

A. H. d'Arcambal, metallurgist for the Pratt & Whitney Co., Hartford, Conn., has continued his studies of high-speed steels at ordinary and high temperatures, and at this meeting presented results on two steels of accepted composition:

Steel	C	Cr	V	W
A	0.63	3.55	0.97	17.04
B	0.65	3.33	1.78	13.85

First, transverse tests were made to determine the best heat-treatment; ½-in. turned bars, 7 in. long, were treated and then ground to ¾ in. Hardness was tested with flat temper-testing Nicholson XF files. A series of bars showed that the greatest fiber stress on transverse rupture, together with requisite hardness, is had on either steel after quenching from 2,350 deg. F. in a lead bath at 1,100 deg. F., cooling to room temperature, and drawing back to 1,100 deg. F. If the final drawing was omitted, the test-bar developed many grinding cracks. Those which could be tested gave only half the strength of the tempered bars.

Grade B showed slight coarsening of grain on the fractured surfaces and probably should have been quenched at 2,300 deg. F. Under the microscope, quenched steel showed polyhedral austenite, with nearly all the original free carbides and tungstides dissolved. Grade B requires a higher draw to remove this polyhedral structure, a little remaining at 450 deg. F., a condition associated with very low strength under transverse test. Both steels give a full martensitic structure after 1,100 deg. F. draw.

Steels of the same class were tested in tension at high temperatures, turning specimens 11 in. long from 1⅛ in. bars, hot rolled and annealed. Two inches at the center was reduced to 0.505 in. in diameter, the test-piece quenched in oil from 2,350 deg. F. and drawn at 1,100 deg. F. A thermocouple was wired to the center of the piece and the specimen mounted in the testing machine so it extended through an electric tube furnace. After holding at temperature for 30 minutes the specimens were pulled.

Temp., Deg. F.	Strength of— Grade A	Grade B
100	243,500	215,000
400	256,500	.....
600	287,500	273,750
800	285,000	260,000
1,000	240,000	223,000
1,100	220,000	200,000
1,200	185,000	160,000

Fractures of Grade A were all of the usual velvety nature. Grade B gave coarse crystalline fractures, possibly due to undisolved carbides. All except those pulled at 1,200 deg. F. remained hard to the file.

Either steel A or B when tested without a high draw is soft to the file until the temperature at fracture attains 1,100 deg. F. In view of the tendency to omit the 1,100 deg. draw this fact is important. An undrawn tool put into use will often run at temperatures of several hundred degrees F., but will be handicapped by being softer than though it had originally been tempered sufficiently to develop the martensitic structure.

None of the samples showed any measurable elongation or contraction. It is worthly of note that properly hardened and annealed high-speed steel attains its greatest strength at about 600 to 700 deg. F., much like plain and other alloy steels.

Steel A quenched, but not drawn, is comparatively weak (175,000 lb. per sq.in.) a figure less than that for hardened carbon tool steel (183,000 lb.).

Tungsten Determination by Specific Gravity

A study of the specific gravity and chemical analysis of a large number of commercial high-speed steels was made by A. S. Townsend, chief chemist of the Cleveland Twist Drill Co., Cleveland, Ohio. He finds that if the specific gravity of a clean piece of annealed steel is determined—a very simple, quick operation—the tungsten content can be obtained to within ± 0.30 per cent by the formula

$$\frac{Sp.gr. - 7.82}{0.049} = \textit{Per cent tungsten}$$

About half of the error is due to ordinary variation in chemical content other than iron and tungsten, and the remainder is due to variation in structure—slag content and amount of free carbides.

Heat-Treatment of 1 Per Cent C Steel

H. J. French and W. G. Johnson, of the Bureau of Standards, presented an excellent investigation of 1 per cent carbon steel, one largely used in tools, dies, bearings and springs, to determine the best combination for strength and ductility. If the steel is to be drawn relatively high, it should be quenched just above Ac_1. If it

is to be drawn at 1,000 deg. F. (538 deg. C.), maximum hardness and tensile strength are had by previously quenching from 1,550 deg. F. (843 deg. C.), which is nearly up to Ac_{cm}. Increased time at the quenching heat acts like an increased quenching temperature—i.e., increases hardness, strength and proportional limit, but decreases ductility.

If a strength of 120,000 lb. is desired, a water-quench before drawing is preferred if the piece will stand it, on account of the higher elastic ratio resulting. If higher strength and ductility are desired at the expense of the elastic ratio, oil-quench from just above Ac_1. In general it is found that a certain draw (especially if low) will give a higher strength if the piece is water-quenched rather than oil-quenched. If the oil-quenched specimens are tempered higher, to give the same strength, they will have a lower hardness.

Good combinations of tensile strength and ductility may be had by high draws, especially if the steel is ground to size after heat-treatment, but the steel has low resistance to impact. Long heatings just under Ac_1 (704 deg. C. or 1,300 deg. F.) result in a decrease of 40 per cent in Brinell hardness, even though there is little or no change in the appearance of the excess carbide.

Steels at High Temperature

An investigation was undertaken by H. J. French at the Bureau of Standards to find a good steel for use in the Haber ammonia process, requiring pressure vessels at 550 deg. C. He now reports on four normalized steels containing about 0.40 carbon, as shown below, and concludes that the chromium:vanadium alloys are the best, because they possess a high limit of proportionality at elevated temperatures, and consequently will not flow like pitch when under load. Test-machine data were recorded with a cinema, as described in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 131, Jan. 19, 1921.

Steel	C	Mn	P	S	Si	Ni	Cr	V
A	0.38	0.56	0.014	0.013	0.14	.....	.....	.....
B	0.37	0.67	0.021	0.010	0.20	3.43	.....	.....
C	0.39	0.59	0.019	0.005	0.23	3.05	0.93	.....
D	0.37	0.74	0.020	0.023	0.21	.....	1.04	0.17

Breaking strengths (load at rupture divided by reduced area) are given in Fig. 1.

According to Jeffries' theory of equicohesive temperature, the fractures in the steels broken at more than about 550 deg. C. should be intercrystalline, while lower-temperature breaks should be transgranular. Microscopic examination of these breaks failed to reveal any great difference—on account of the fine-grained distorted structure it is impossible to state what is the ruling type.

Theory of Hardening

Prof. O. E. Harder, of the University of Minnesota, presented a clearly written paper emphasizing one aspect of the theory of hardening—i.e., the importance of solution and precipitation as a cause of hardness in steel and other alloys.

A great many alloys can be usefully hardened: carbon steel, many alloy steels, duralumin, and certain Al:Mg alloys. Experiments with them yield many points in common. For instance, well-made annealed pieces, when cooled at a correct rate after an appropriate heating, possess an increased hardness and exhibit a structure consisting of an assemblage of polyhedral crystals, all alike—in other words, a solid solution. These pieces can be further hardened, sometimes by mechanical work, sometimes by further cooling, sometimes by aging at room temperature, and always at a rapid rate of tempering. This last-mentioned increase in hardness may result in no change in the microscopic appearance. Hardening steel by mild tempering causes distinct changes in appearance; further and higher tempering causes a loss in hardness and the final appearance of recognizable crystals of iron carbide.

These facts all conform to the supposition that a substance which existed in the original piece is much more soluble at a high temperature than at lower, particularly at ordinary atmospheric temperature. Further facts confirm this. When a steel is originally heated, there is an absorption of heat and a contraction in volume when the separate crystals merge into one another and form the solid solution. This is exactly what happens when salt and water, etc., form liquid solutions. Carbon steels on slow cooling expand and liberate this heat of solution when the carbide is reprecipitated, as would be expected in a reversible process of solution and precipitation.

However, quenching locks the solute and solvent in a metastable condition. The tendency for the now insoluble solute to precipitate exists, but there is not the necessary internal mobility or plasticity to allow of the atomic rearrangements. Prof. Harder believes that maximum hardness ensues after this condition of false stability has changed into one of actual instability and complete precipitation of the insoluble constituent has occurred in the form of the finest possible particles which can exist as separate crystalline entities. It requires several molecules to form these particles; how many is not known, but they are doubtless far too small for microscopic observation. As an instance, quenched nickel steel is austenitic; it is in the metastable state. Further cooling decreases the solubility of the carbide more and more until finally the tendency to precipitate overcomes the hindering forces, and actual precipitation of cementite occurs with the evolution of heat. The microscopic appearance now suggests martensite, and there is a notable increase in hardness. It

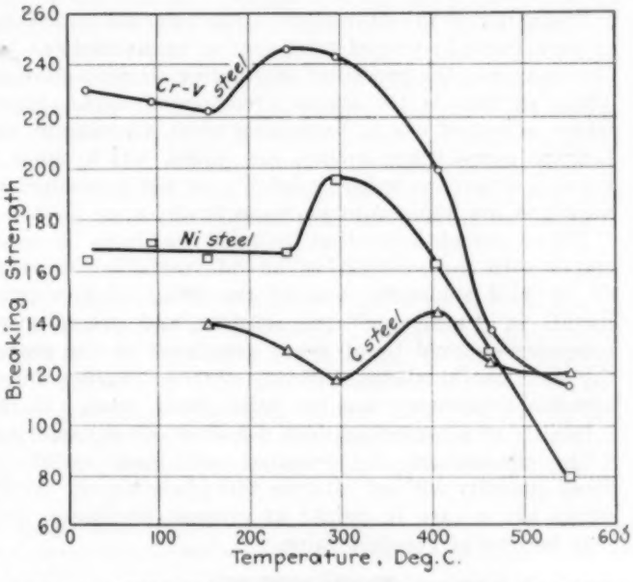


FIG. 1. BREAKING STRENGTHS OF STEELS AT HIGH TEMPERATURES

should be noted that the metal as a whole is too rigid to permit an appropriate increase in volume required by the combined volumes of solute and solvent; no expansion is observed and the metal is therefore under high internal stress. Prof. Harder considers that the effect of such stresses has not been given the attention its importance warrants as a principal cause of hardness.

The laws of physics indicate that these tiny particles will accumulate into larger ones if given an opportunity. Tempering allows this. Steels change in microscopic appearance and decrease in hardness (decrease in internal strain) as the particles grow. But not all of the insoluble material may have come out at one time. Jeffries and Archer's *critical dispersion*[1] is therefore thought to be that point where the softening effect of crystalline growth becomes of greater magnitude than the hardening effect of continuing precipitation of tardy particles.

Rosenhain[2] notes that the hardness of solid solutions is greater than that of either constituent and that it is greatest at saturation of the constituents each in the other. On the basis of this general rule, austenite may be regarded as a highly saturated solid solution, and the change into martensite (with further hardening) is an increase in the saturation, due either to a change in the solvent (gamma to alpha iron), a new solute (carbon changing into carbide), or merely a great change in mutual solubility of two unchanged substances with decreasing temperature. This only applies when martensite is regarded as a solid solution; Rosenhain's theory does not cover heterogeneous systems after precipitation has commenced.

The action of alloys in steel or other metals is thought to be principally one of retarding or catalyzing (as the case may be) the processes of solution or precipitation. Thus, in the Al:Cu alloys a compound $CuAl_2$ forms which is not of use in hardening until magnesium and perhaps some other metals are added which cause a greater difference in the solubility of the compound at high and low temperatures respectively.

These conceptions—that unusual hardness is associated with the presence of an intermetallic compound of variable solubility, and of the effect of additional metals in "catalyzing" the solution and precipitation processes—should be of great assistance in the search for new useful alloys. Binary systems having intermetallic compounds are the most likely ones. If the solubility of a compound does not show great variations with temperature, try whether additional metals in small quantity will not catalyze this phenomenon. Al:Fe alloys are a case in point; at present worthless, they may become of greatest value.

The Pulp Industry of Pennsylvania

The Bureau of Research of the State Department of Forestry, Pennsylvania, has just completed an initial survey of the pulp industry of the state. The capital investment is stated as $50,000,000, with average annual value of production placed at $60,000,000. The industry is giving employment to 7,144 persons, with total annual wages of $12,500,000, or an average yearly wage of $1,750. In connection with the survey, it is shown that a large amount of wood is imported annually from other states. Very little of Pennsylvania pulp, it is set forth, is utilized for newsprint manufacture.

[1] CHEM. & MET., vol. 24, No. 24, p. 1057, June 15, 1921.
[2] CHEM. & MET., vol. 25, No. 6, p. 243, Aug. 10, 1921.

Consumption of Coal by Principal Uses

The uses of coal are classified in the following summary issued by the U. S. Geological Survey as a portion of its weekly coal report dated July 23. Although the actual tonnages do not apply strictly to other years than 1917, the proportion probably is much the same for any typical year. In commenting on the table, the Survey issues the following comment and warning:

It must be remembered that consumption is not the same as production. Not only must exports and imports of coal be taken into consideration but the flow of coal in and out of storage must be reckoned with. Further, there is great variation in the quantity of coal actually consumed from year to year, depending to some extent on the weather and to much greater degree on the activity of the industries which are the chief consumers of coal.

The proportion of the total coal consumed, taken by different industries, does not vary so greatly, and the percentages shown in the table below are roughly constant from year to year. The table represents in a general way the conditions during 1917, a year of large consumption. The principal changes since 1917 have been an increase in the proportion exported and a transfer of some millions of tons from beehive to byproduct coke. The proportion consumed by the two types of coke ovens combined has undergone little change.

COAL CONSUMED IN THE UNITED STATES AND EXPORTED

(The figures for bituminous coal in this table represent in somewhat generalized form the calendar year 1917; those for anthracite, the coal year ended March 31, 1917)

	Quantity (Net Tons)	Per Cent
Bituminous coal:		
Industrial plants	174,600,000	31 7
Public utilities:		
Electric	31,700,000	5 8
Gas	4,960,000	0 9
Railroads	153,700,000	27 9
Domestic consumers	57,100,000	10 3
Power and heat at mines	12,100,000	2 2
Exports	22,900,000	4 1
Bunkers:		
Foreign trade	6,700,000	1 2
Coastwise and Lake trade	3,600,000	0 7
Beehive coke	52,240,000	9 5
Byproduct coke	31,500,000	5 7
	551,100,000	100 0
Anthracite:		
Domestic consumers (domestic sizes)	49,400,000	55 1
Artificial gas plants	1,650,000	1 8
Steam trade (industries, power plant, and heating large buildings)	18,450,000	20 5
Railroad fuel	6,400,000	7 1
Power and heat at mines	9,350,000	10 4
Exports	4,600,000	5 1
	89,850,000	100 0
Grand total	640,950,000	

Lumber Value of Pine Trees Not Affected by Turpentining*

The operation of turpentining pine trees does not lower the strength or resin content of the wood. The crude turpentine, or oleoresin, is not drained from a store in the tree, but is manufactured under the stimulus of the wound by living cells in the sapwood immediately adjacent to the cut on the trunk. No turpentine is produced by the heartwood, because all of its cells are dead. The heartwood may be saturated in places with pitch, but this does not readily flow out as does the resin freshly formed in the sapwood. The major part of the tree is not appreciably affected, and the loss due to death of trees or to a reduction or degrading of lumber is very small when the proper method of turpentining is followed; this loss is more than offset by the additional revenue obtained through turpentining.

*From U. S. Forest Products Laboratory *Technical Notes*.

American Ceramic Society—Executive Meeting

Report of Conference of Board of Trustees. Officers of Divisions and Sections, Members of Committees and Ex-Presidents—Held to Formulate General Program of Activities for Increasing Technical Service to the Clay-Working Industries

PRESIDENT PENCE called a conference of the leaders in the American Ceramic Society at the Commodore Hotel, New York City, Sept. 15-17, for the purpose of counciling together with the new organizing secretary on methods, policies and plans of activities to be entered into for the future growth and service of the organization. The meeting opened as per schedule on the morning of Sept. 15 and Ross Purdy was elected temporary or informal chairman with the privilege of entering into the discussion. Full stenographic notes were taken at this and all subsequent sessions and are available at the secretary's office in Columbus, Ohio.

Definition of Objects of Society

Considerable discussion ensued on the definition of the objects of the society, and it was thought by some members that the aims and methods of accomplishment of them should be set forth in detail. Motion was made by Mr. Barringer and subsequently carried that the definition of the objects of the society be approved as set forth in the constitution—namely, "to advance and promote ceramic arts and sciences by meetings, publications, literature, journals and other activities."

Chart for research organization was then taken up. The term "research" was here used in the broadest sense. Eventually it was agreed that the chart should be considered a grouping of service committees, so organized under the co-ordinating council of committee chairmen that service and activities with outside agencies and associations might be greatly facilitated. This chart does not include any of the committees functioning on the strictly internal affairs of the society. It is thought these will continue to serve as in the past directly under the board of trustees. The chart as finally approved and recommended to the board of trustees of the society by motion carried in this conference was as follows:

CO-ORDINATING SERVICE COUNCIL

Organizing Secretary as Chairman, and Consisting of Four Other Members Appointed by the Board to Serve as Committee Chairmen 1-4

		Committee Members Appointed by	Co-operation With Other Organizations
1. Com. on Research	Pure Science	3 members appointed by board	N.R.C. div. chem. and chem. tech.; federal bureaus; semi-public, commercial and industrial labs.; universities
	Applied and Industrial	1 from each division	N.R.C. div. research extension; N.R.C. div. engineering; federal bureaus, etc.; industrial associations; universities
2. Com. on Standards	Definition	3 members by board	A.S.T.M. Committees C-I to C-II inclusive and D-I, D-9 and E-I; ceramic societies abroad, industrial associations, federal bureaus, etc.
	Raw Materials Specifications	3 members by board	
	Standardization of Tests	1 member from each division	
	Specification of Products	1 member from each division	
3. Com. on Geol. Surveys		4 members by board	N.R.C. div. geol. and geography; U.S. Geol. Survey and state surveys
4. Com. on Symposiums, Monographs, Bibliographies, Statistics		1 member from each division	National Research Council; industrial associations; federal bureaus; commercial laboratories; universities

This council of committees will have power of recommendation to the board of trustees and will absorb several service committees which are now covering the same work. The purpose of this form of organization is wholly to aid in outside contacts and obtain co-operation between committees.

The feature of honorary membership for those who by inventions, investigations, organization or artistic developments have merited recognition as having materially advanced ceramic art and science has been neglected for many years. The promotion from associate to active membership has been carried out at times in a careless way. The membership committee is to look up the question of honorary memberships.

The motion was carried that it was the sense of the conference that the board of trustees should scrutinize more closely the status of those to be elevated to active membership. It was further carried that the question of perpetual membership in the society wherein one fee is paid to keep the member's name forever on the roster of the society be referred to the membership committee for consideration and recommendation.

Local Sections

Discussion of redistricting local sections merged into talk of having the society allot dues to sections; the elimination of sections and strengthening of divisions; having permanent headquarters for divisions; types of programs for local section meetings, and development of new membership by meeting with other local bodies like the sections of the American Chemical Society and engineering societies. The motion was carried that the entire question of local section organization be referred jointly to the committee on membership and that on sections and divisions, because the interests of each are involved, with the request that they return a report.

Ceramic Schools

The questions of ceramic trade schools, courses in high schools and art schools and clubs were considered together. A successful trade school is now operating at Trenton, N. J. Others are recommended at Zanesville, and East Liverpool, Ohio. Many high schools have art pottery courses, the total number having some sort of equipment exceeding 300. Over 2,000 teachers in the United States are engaged in this sort of work. Motion was carried to recommend that the board of trustees consider seriously the advisability of establishing trade schools and promoting courses in other schools. Frederick H. Rhead is to work up a brief of opinions from authoritative sources on the possibilities

for such action and bring it with above recommendation before the board of trustees.

Committee on Ceramic Education

The matter of ceramic education is now left to the direction of the instructional force in each university. It may be that the instructors would like to have some means of contact for advice and information as could be provided by a committee of the society. It would be very queer if the instructional force in any university would not welcome the support of a committee whose interest is general and representative of the territory outside the immediate territory being served. This committee could really study the courses, the equipment and the kind of work being done and give sound advice. The motion was carried to recommend to the board that it consider establishing a committee on ceramic education to function independently of other existing committees.

Division of Organization

Opinion was expressed that the white ware division should be devoted to the pottery industry and electrical porcelains and others formed into a separate division. The terra cotta division is co-operating successfully with the National Terra Cotta Society. The new art division is getting under way with a program for the next meeting.

Divisions should each outline their research problems and take them up with others to try to discover the best method of attacking them. As to how they would be undertaken, whether by individual industrial laboratories, fellowships or federal bureaus, would depend largely on the type of problem. The Bureau of Mines, for instance, wants all the help it can get, whether through committees of the American Ceramic Society or other sources. Everyone interested is approached on each problem undertaken. It was decided that society committees could be of valuable assistance in promoting research for the industries in the various agencies.

The motion was carried that recommendation be made to the board of trustees that the matter of issuance of a bimonthly bulletin from the secretary's office be taken under consideration in order to determine if such a bulletin can be issued without great financial burden to the society.

Endowments

The society should have some fixed policy regarding endowments. Plans are being formulated for the Ernest Mayer fund, and those who have it in charge desired some general expression from the conference. The consensus was that the board of trustees continue to handle endowment funds and that further ideas may be developed by the secretary's office.

A motion was carried that the secretary proceed through the present committee on European excursion to make arrangements for an excursion to England or Europe that will include all the clay-working industries in addition to the glass works.

Annual Convention

Arrangements of divisional meetings at the annual meeting are unsatisfactory, because a great many members would like to attend the different divisions and hear the papers. They are unable to do so because of simultaneous readings. Papers of general interest might be given both before general assembly and divisional meetings. Abstracts should be required in order properly to place papers in divisional meetings or the general meeting, or reject them entirely. Reprints would save considerable time at the meetings as worked out by the American Electrochemical Society.

Motion was carried that it be recommended to the board to place a stenographer in each divisional meeting and in the general session to take record of discussions.

After some debate the motion was carried that an exhibition be organized for the annual convention and the society rent space to exhibitors. The exhibits can replace some advertising papers that are now given on the programs. Such papers cannot be eliminated, however, where they deal with engineering data or new developments.

The motion was carried that the society should neither establish a testing laboratory nor act as a clearing house for existing laboratories. Such institutions should advertise in the *Journal*.

Chemical Exposition

The motion was carried that if the board of trustees decides to have a booth at the next Chemical Exposition the matter of having exhibits be seriously considered.

Publicity

Even a technical organization that is as formal as it can be, as dignified as it wishes to be, if it is to be effective, must publish the fact that it exists and the work it is doing. This applies to both internal and external publicity. It was agreed that the best type of publicity was to get news items into other journals. This is a duty of the organizing secretary.

The motion was carried to approve a publicity program involving uses of reprints and inclosures for general distribution; addresses before conventions or other associations, clubs, schools, etc.; and articles for publication in newspapers and magazines.

Centralization of Business Activities

It was carried by unanimous vote to recommend to the board of trustees that the office of secretary and editor of the *Journal* be combined and that for the following year the general secretary shall act as editor.

The consensus seemed to be that the general office of the society should remain at Ohio State University, Columbus, Ohio, for the present, but that when finances permitted it might better be located in a larger business center.

The Brass and Copper Industry in Canada

An official report on the brass and copper industry of Canada in 1919 (the latest statistics to be had) gives the number of individual plants as fifty-nine—thirty-nine in Ontario, twelve in Quebec, three in British Columbia, three in Manitoba and two in New Brunswick. The total capital investment in that year was $15,054,981, consisting of land, buildings and fixtures, $3,099,676; machinery, tools, etc., $3,285,942; materials on hand, stocks in process, etc., $3,362,238; and cash, trading and operating accounts, etc., $5,307,125.

Employees numbered 2,778 males and 343 females, to whom salaries and wages aggregating $3,642,663 were paid in 1919. Employees earning $30 per week and over numbered 600.

Operation of Fatty Acid Distillation Plants

Equipment of Modern Fatty Acid Distillation Plant—Preliminary Tests on a New Installation—Operating Technique for the Production of Single-Distilled and Double-Distilled Fatty Acids—Yields and Operating Costs

By OSCAR H. WURSTER
Chemical Engineer, Chicago, Ill.

ECONOMIC conditions during the post-war period brought about a greater expansion in the fatty acid distillation industry than the country has experienced in any previous similar length of time.

In discussing the design, construction and operation of distillation plants with owners and operators many questions have from time to time been asked, the answer to which the writer has thought might be incorporated into one article.

The operation of a "going" fatty acid distillation plant with experienced operators becomes a reasonably simple matter. But to start up a new plant appears less simple to operators only partly familiar with the process. Furthermore, some of the conditions necessary for the smooth and successful operation of the plant are not always easily maintained. For the best results the system must be continuously in equilibrium —proper temperature balances must be obtained.

An inexperienced or partly experienced operator will find it useful to be able to recognize indications that the plant is not running properly, and will be further benefited by a knowledge of how to restore normal operating conditions.

We trust, therefore, that these directions and comments will be useful as simple operating instructions to the beginner, and that they will be found at the same time to be sufficiently complete and comprehensive to guide him in the best and most efficient operation of the plant as he becomes more experienced.

The writer takes this opportunity of thanking several of his friends among distillation plant operators, to whom the first draft of this paper was submitted for criticism, for useful suggestions and further questions.

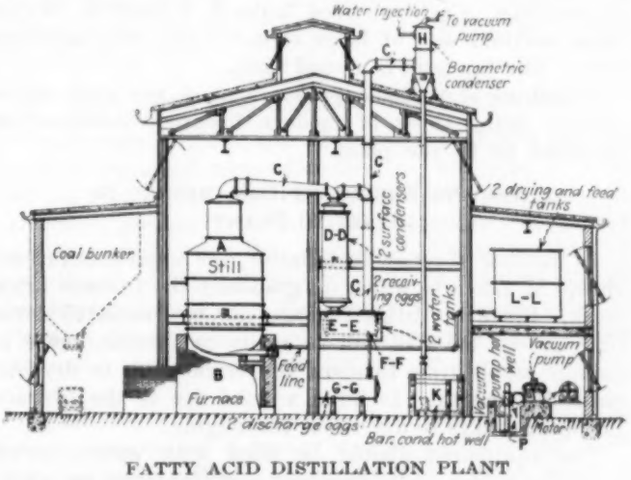
Construction of Fatty Acid Distillation Equipment

Referring to the accompanying figure, the still *A* is constructed of cast iron of sufficient thickness to give it proper strength and to insure its satisfactory wearing qualities. Being built in sections with separate bottom, cover and dome, the bottom, which receives the hardest wear, can be replaced. To facilitate this the still is carried on lugs bolted to the side of the still, leaving the bottom to hang free into the furnace. Present experience indicates the average life of a bottom to be about five years, the still lasting very much longer.

A brick furnace *B* to fire the still externally and to superheat the injected steam is built under the still. This furnace is of such design that the heat is distributed as uniformly as possible over the bottom of the still. The still bottom is designed to give a maximum heating surface. Local overheating of fatty acids tends to burn the stock, increasing the tar yield by decreasing the yield of good distilled fatty acids and affecting the color and odor of the distillate. The superheated steam is introduced through a manifold, or "spider," with legs provided with openings placed to give a thorough distribution of steam and to circulate the contents of the still to further avoid local overheating.

Coal is at present most generally used for firing. Oil and gas are used in some plants. The latter can be applied more effectively and efficiently, thus the fuel cost is not as much greater as the difference in cost of these fuels would indicate. The greater ease with which the still temperature can be controlled and maintained uniformly is also conducive to higher yields of good distilled product.

The pitch produced in the stills has also been used mixed with crude oil as liquid fuel to fire the still and superheater furnaces. Some of the indirect methods of heating have also been used. There is, however, not sufficient difference in thermal head between the required still temperature and the temperature of the



FATTY ACID DISTILLATION PLANT

fluid heating medium in a system operating under moderate pressure to make this method a success, and when water is used as the heating medium the pressure required on the heating system is so high that further engineering problems are introduced.

A satisfactory indirect heating method—that is, one in which a fluid at high temperature would be heated at some distant point, as in the boiler room, and circulated through a coil within the still—would be very desirable. The temperature control of the still would be improved, there would be less wear on the still bottom, the furnaces and heat would be removed from the still room and fewer and more efficient furnaces could be used.

The surface condensers *D*, *D* are of the vertical type

and are usually constructed with copper dome, tubes and bottom chamber. The water jacket is steel. Under the condensers are placed copper expansion chambers or receiving eggs *E*, *E*, in which the condensed fatty acids separate from the vapor. The steam and uncondensed fatty acids pass on, while the liquid flows down to the copper discharge eggs *G*, *G*. When two discharge eggs are used, they can be shut off from the system alternately, the vacuum broken and the collected fatty acids pumped to storage. When but one discharge egg is used, the fatty acids are allowed to accumulate in the receiving eggs *E*, *E* until the discharge egg *G* is emptied.

The vapor piping *C* connecting the still, surface condensers, receivers and barometric condenser is copper. All these various pieces of equipment have been built of aluminum also, but under practical operating conditions copper has generally been found to be most satisfactory.

The steam and non-condensible gases passing the surface condensers *D*, *D* pass on to the barometric condenser *H*. This is usually steel or cast iron and of the counter-flow type, the vapor entering near the bottom and the condensing water near the top. The non-condensible gases and air introduced with the steam and through leaks are taken off the top of the barometric condenser *H* by the vacuum pump *S*, thus maintaining the vacuum on the entire system. A simple rotary type of vacuum pump has in recent years been found to be exceptionally satisfactory, maintaining a uniformly high vacuum, having a very large working capacity and being economical both in first cost and in operation and maintenance.

The hot-wells *K*, *P* and catch-basins are usually built of concrete. Cast-iron feed tanks *L*, *L* built in two or three sections and of large capacity are very satisfactory. The tar tank is a steel tank.

Buildings of various types are used, the most satisfactory being those of modern fireproof construction designed to fit the plant.

Testing Equipment Preliminary to Starting Plant

In the case of a new installation, the usual precautions should be taken to warm up gradually the furnace brick work. Since the brick furnace can be completed some time before the still will be ready to operate, there is usually ample time to allow the brick work to dry out naturally and then to build a wood fire in the furnace for several days to dry it out thoroughly.

The equipment should be filled with water, tested for leaks under 15-lb. pressure and tightened up wherever such leaks are found. After drawing off the water, vacuum of 26 to 27 in. should be pulled and held on the entire equipment. With the entire installation in good shape, as shown by these tests, the still is ready to be put in operation.

Single-Distilled Fatty Acids

Preparation of Fatty Acids for the Still

The "split" or saponification of fatty acids for distilling purposes should be as high as can be practically obtained—that is, 94 to 96 per cent. The fatty acids, by whatever process produced, should be thoroughly freed, by washing if necessary, of sulphuric acid, calcium sulphate (lime salts) or sodium carbonate and sodium sulphate (alkaline salts). After washing and settling, the crude fatty acids are ready to pump to the drying and feed tanks. To dry the fatty acids thoroughly, they are heated in the drying and feed tanks to a temperature of 220 deg. F., being agitated at the same time with air. By drying under these conditions, there is positive assurance that no moisture is left in the stock. Feeding water into the hot still (425 to 550 deg. F.) causes the sudden formation of a large volume of steam, in the expansion of which stock is carried over to the condensers, causing discoloration. In other words, the still "primes over." Feeding a large quantity of relatively cold water into the still is also very likely to result in damage to the still bottom. In some of the older plants the fatty acids are not preheated in this manner, but the water is settled out by allowing the fatty acids to stand hot for longer periods of time in large wooden tanks. This requires somewhat more storage capacity and also a greater lapse of time in the preparation of fatty acids for the still. There is at the same time always a possibility of feeding some water into the still with the fatty acids, whereas if all fatty acids in the feed tank have been heated to 220 deg. F. with air agitation, it is impossible to feed water to the still from the feed tank.

Charging and Starting Still

Vacuum is pulled on the still, and at the same time about 15,000 lb.[1] of hot fatty acids from the feed tank are fed to the still. This quantity of fatty acids will come to an inch or two of the center of the gage glass, and the level of the fatty acids should show in the gage glass throughout the entire run until running down to tar. Fire is now built under the still. (Never have fire under empty still.) Steam is turned in through the superheater. If the still is cold so that stock fed in on start is cooled below 200 deg. F., the still may be warmed up until the stock shows a temperature of 200 deg. F. or slightly above before turning in the superheated steam. At the same time fire is built in the superheater furnace. The reducing valve on the steam line is set so that the steam goes to the superheater at from 15 to 20 lb. pressure. All of the valves on the superheater sections are set wide open. The regulating is now done on the main valve next to the still. If, to provide for emergency, two valves are placed on this line, the first valve is set wide open and the regulating is done on the main valve next to the still. The same valve should always be considered as the "emergency valve," and therefore, always being wide open or closed, the seat and disk will be free from wire-drawing. The regulating valve is now so set that the steam goes to the still at about zero pounds pressure. (Whether the steam should go to the still under slight vacuum or slight pressure depends upon how the superheater sections are connected. If connected in series so that all of the steam passes through each section, then the steam may go to the still under several inches vacuum. If, however, the superheater sections are connected in parallel so that the steam is divided and a fraction of it passes through each section, then the steam should go to the still either under zero pounds pressure, or preferably 1-lb. pressure, so that the presence of steam in each section is assured, otherwise it is possible to burn out a superheater section.) A small amount of water is turned on to the

[1] All figures given which are dependent upon the size and capacity of the still refer to a still 9 ft. in diameter by 17 ft. deep, with 1,000 sq.ft. of copper-condensing surface in two condensers.

barometric condenser. The surface condensers and the steel tanks containing the receiving eggs are filled with warm water.

The still temperature is brought up to about 450 deg. F. and the superheater temperature to about 550 deg. F., as rapidly as possible. As the temperature rises, some steam will condense in the surface condensers and collect in the discharge eggs, and this is blown or pumped out as necessary. Fatty acids will start to distill over at 410 to 425 deg. F. As the system heats up and rapid distillation takes place, it becomes necessary to turn on sufficient water to both surface condensers and the barometric condenser to control the temperatures properly. The water going to all condensers should have a temperature of 100 to 110 deg. F.—that is, the temperature of the cooling water going to the condensers should be slightly above the melting point of the fatty acids being condensed. (If the temperature of the water is taken at the pump on the ground floor or at some other point at a distance from the condensers, allowance must be made for further cooling.) The hot water coming from the surface condensers should be about 140 deg. F. and the water in the down-leg of the barometric condenser should be 115 to 120 deg. F. It is usually found that the cooling water temperatures of the two surface condensers can be so regulated to advantage that the water coming from the first surface condenser will be about 160 deg. F. and that coming from the second surface condenser about 130 deg. F. As the fatty acids distill over, crude fatty acids should be fed to the still to keep the level in the gage glass constant. If it becomes necessary to discontinue feeding at any time because the fatty acid level in the still is too high, then the feed line should be blown out with steam to prevent the freezing of fatty acids in the lines. If the feed tanks are located sufficiently high to get a gravity feed to the still and there are no "pockets" in the feed line, then the vacuum on still will generally draw all fatty acids from feed line if only the valve at the feed tank is closed. Care, however, should be taken that no air is drawn into still through leaks in feed line.

Control of Condensers

The above condenser water temperatures are given having in mind the distillation of cottonseed oil, garbage grease and similar low titered fatty acids. The practice is to run the cooling water to all condensers at a temperature just slightly above the melting point of the fatty acids being distilled so as to prevent same from solidifying on the condenser tubes. The cooling water should be taken from the surface condensers as cold as possible to obtain maximum condensation of fatty acids, but not so cold that an excessive amount of steam will be condensed with the fatty acids—that is, 130 to 140 deg. F. (The fatty acids as blown from the eggs will contain from 10 to 20 per cent water.) The temperature of the condensing water in the down-leg of the barometric condenser should be as low as is consistent with economy in the use of cooling water, as thereby the efficiency of the vacuum pump is increased.

With higher titered fatty acids, the condenser water temperatures are increased accordingly. With stearine fatty acids, the cooling water is run to the condensers at 120 to 130 deg. F., the overflow from the surface condensers will be 140 to 160 deg. F., and the barometric down-leg will be 130 to 140 deg. F.

It is not necessary to circulate water through the steel tanks holding the receiving eggs. On the other hand, should the water in these tanks become cold, as in between runs, then it should be heated with steam, or the cold water should be run out and replaced with hot water. These tanks should preferably be equipped with a small (½-in.) steam line so that the water in them can be at all times maintained at a temperature somewhat above the melting point of the fatty acids being distilled.

Steam Consumption and Rate of Distillation

One pound of steam, approximately, is required to distill 2 lb. of fatty acids. Instructions were given above how to set the steam valves to start operations. During the first few runs it can be determined if the proper amount of steam will be supplied in any particular installation and under local conditions with the valves set as directed. With still temperatures and steam pressure as directed and other conditions normal, if the still does not deliver its rated output, it is probably due to insufficient steam supply. In starting up a still on crude fatty acids and in redistilling single-distilled fatty acids, 1,500 to 2,000 lb. per hour should be distilled. If, on the other hand, the rate of distillation is high, condenser temperatures maintained by adequate water flow as directed and other conditions normal and an excessive quantity of fatty acid is going to the barometric condenser (as indicated by the accumulation in the barometric condenser hot-well), then it is very probable that too much steam is being turned into the still, with the result that fatty acids are distilling over at a rate exceeding the capacity of the surface condensers to condense same and some of the fatty acids pass on to the barometric condenser. In either case, proper regulation of the steam supply should be made.

Cooling Water Required for Condensers

Approximately 150 gal. of water per minute per still will be required when distilling at the rate of 1,000 lb. per hour. Since the rate of distillation will at times be much greater than this, correspondingly more condensing water will be required. From one-half to two-thirds of this condensing water is required for the barometric condensers, the balance for the surface condensers, the proportion, of course, depending somewhat upon the temperatures maintained in the surface condensers.

When the still is operating at a maximum capacity, the necessity for a larger quantity of cooling water can be partly offset by running the cooling water to the condensers at a somewhat lower temperature, say 90 to 100 deg. F. This, however, must be done carefully and by an experienced operator, since there is always the danger of freezing fatty acids locally in portions of the condensing system, and such local freezing occasionally results in choking up the entire system by closing the passageway for the gases and vapors.

The freezing of fatty acids in the condensers and serious choking up of the system is usually indicated first by the dropping of the vacuum on the still. Partly solidified fatty acids will show in the sight glasses over the eggs, and the flow to the eggs will gradually cease, the white solid fatty acids showing in the glass. Then, if the condensing system is examined, the vapor

pipe leading to the barometric condenser will probably be found cold and the second condenser may be cold, as well as the vapor line from first to second condenser. It will also be noted that the condensing water will leave a frozen surface condenser at about the same temperature at which it enters. The operator no doubt will note the trouble long before the first condenser closes up. To open the system, the cold water should be drained from the steel water jackets and these be filled with hot water. If an open steam line was connected into the steel jackets in the erection of the plant, it is a simple matter to turn off the water supply and turn on steam until the water boils. The water in the steel tanks surrounding the receiving eggs should be brought to boiling with open steam. The trouble, once discovered, is quickly eliminated. Should the whole system become solidly frozen through inattention, it would probably be advisable or necessary to draw the fires, but such an extreme case has never come to the writer's attention.

The discharge eggs are blown out or pumped out alternately as they fill up. We recommend pumping out the fatty acids from the discharge eggs. Blowing out with air is common practice and is also satisfactory. Blowing out with steam is not satisfactory. A 2-oz. or 4-oz. sample of the fatty acids from each egg should be taken and held for reference. This sample can either be taken at the discharge into the storage tank, or, more conveniently, from a petcock in the discharge line near the eggs.

Uniform Firing Increases Yield

The still and superheater furnaces should be fired uniformly and the feeding to the still should be uniform, as it is only in this way that uniform temperatures and even distillation can be maintained. With careful and sensible firing, about 100 lb. of coal per hour per still will be required for still and superheater furnaces combined. The quality of the distilled product is improved and the yield of good colored fatty acids increased by maintaining a uniform still temperature and even distillation. When operating in this manner, it will be necessary to make only slight and gradual changes in the cooling water supply. Large variations in temperature resulting from poor firing or from suddenly feeding large quantities of relatively cold fatty acids to the still interfere with the smooth and uniform distillation of fatty acids and also interfere seriously with the smooth and proper operation of the still in that it requires frequent changes in the condensing water supply.

During the first run of a new still the several valves controlling the water supply to various points in each surface condenser can be, by careful regulation, so set that they will thereafter require practically no attention, the future regulating of the water supply to each surface condenser being done entirely by the single-control valve in the line feeding the separate supply lines.

Length of Runs Varies With Pitch Yield of Stock

When feeding black fatty acids to the still, from 50,000 to 125,000 lb. of stock can be fed to the still before running down to tar, this depending upon the amount of pitch obtained from the material being fed. In the case of fatty acids obtained from cottonseed oil foots, 50,000 to 60,000 lb. will constitute a run, whereas with fatty acids from garbage grease or low-grade animal fat from which the pitch yield is relatively low from 60,000 to 125,000 lb. stock may be run. The character of the distillate—that is, its color and odor—will indicate when it is time to run down to tar. When the distillate becomes so dark that it can no longer be classed or used as once-distilled stock, there is no object in continuing the run. Feeding to the still is then discontinued. To some extent the amount of stock fed is also controlled by the preference of the operator. Some operators prefer short runs of about 60,000 lb. yielding about 3,000 lb. pitch, with less time consumed in running down to tar.

Running Down to Tar

After the feeding of fresh stock to the still is discontinued, the still temperature gradually rises. The temperature of the superheated steam should be forced up accordingly. After the fatty acids can no longer be seen in the gage glass, samples should be drawn from the tar sampler regularly to determine the consistency of the residue in the still. As the still temperature approaches 550 deg. F. and the superheated steam has been forced up to about 650 deg. F. most of the fatty acids will have been distilled over and frequent samples should be taken from the tar sampler. The first samples taken will be thin and oily. As the temperature rises, the pitch will become thicker, more "rubbery," but on drawing out between the fingers will be "short" and greasy. The point at which the tar should be drawn from the still will be approached when the sample drawn will pull out in long threads and is fairly dry when worked in the fingers. So long as samples can be drawn out from the tar sampling tube, there will be no difficulty in drawing the tar from the still.

Tar from acidulated cottonseed oil foots hardens more quickly than that from garbage grease and animal greases. With the latter stocks, higher still temperatures, from 575 to 600 deg. F., must be reached before drawing pitch. Temperatures above 600 deg. F. are not required to give a hard pitch. If the still temperature rises too rapidly and shows signs of going above 600 deg. F., it should be checked by regulating the firing. When, however, a sample can no longer be drawn from the sampling tube or if the last sample drawn is fairly dry and hard when cold and draws out into long threads when pulled—in other words, is thick and viscid and rubber-like—then the pitch should be withdrawn immediately from the still. As the samples indicate that the pitch in the still is thickening and must soon be drawn from still, no fresh fuel, if coal is burned, is added to the furnaces and the temperature is maintained by breaking up and burning freely the fuel already on the grates. This will leave a relatively small amount of fire in the fire beds when it is time to draw the tar.

Drawing Tar

The fires are drawn from the furnaces, or the burners turned off if gas or oil fuel is used, the valve on the vacuum line to the barometric condenser is closed and steam is turned on the ejector on the tar tank. The vacuum on the still starts dropping. When the still vacuum is down to zero, or at most 1 to 5 in. and a vacuum of about 20 in. has been pulled on the tar tank, the superheated steam into the still is shut off (and

the superheaters vented to the atmosphere) and the tar cock on the still opened. In making a first run, an inexperienced operator can, by hammering on the 4-in. tar line before drawing tar, familiarize himself with the clear ring of the empty pipe as distinguished from the deadened sound obtained when hammering on the tar line while the tar is running. (The flow of the tar in the tar line can also be felt by placing one end of a pencil on the tar line and pressing the teeth against the other end.)

After the vibration of the tar line ceases, showing that the flow of tar has discontinued, and the tar line rings clear and the vacuum on the still rises and equalizes with the vacuum on the tar tank, then the 4-in. cock next to the tar tank is turned so as to close off the tar tank and open the tar line discharge to the atmosphere. Steam through the superheater is again turned into the still and the still thoroughly steamed out for 10 or 15 minutes. The condensation and tar thus blown out are collected in a barrel placed under the open discharge next to the tar tank. It should be pointed out that whenever steam from the superheater to the still is shut off while there is fire in the superheater, or the superheater furnace is hot, the bleeder to the air between the superheater and the still should be opened so as to pass at least a small amount of steam through the superheater to prevent overheating or burning out.

In some plants it is not the practice to turn off entirely the superheated steam to the still while drawing tar. From 5 to 8 lb. pressure is left on the superheater. The temperatures are so high that the steam is not condensed in the tar, but passes out of the still to the condensers. The manipulation of the still at a time when the operator is extremely busy is thus materially simplified.

Regulating Condensing Water

No mention has been made of regulating condensing water while running down to and drawing tar. This is optional. Less water is, of course, required as less stock passes over, and the extent of the regulation will be determined by the source of the water supply and the possible economy which may be effected.

After the still has been steamed out, superheated steam to the still is shut off, the tar cock on the still is closed and the still is ready for another run. After the cock in the tar line next to the tar tank is turned so as to shut off the tar tank and vent the tar line to the atmosphere, then the valve on the suction line between the ejector and tar tank is closed and steam turned off of ejector. If the tar is drawn from the still very hot, say above 575 deg. F., the ejector should be left on the tar tank for an hour or so as a precaution to remove gases given off and avoid pressure developing in the tank.

Mention should be made here of the remedy in case it is found that the pitch has become too thick to flow, or has become spongy and cannot be drawn from the still. This is of infrequent occurrence and is apt to be so troublesome that after an operator has had the experience once he is quite likely to avoid a recurrence. The tar cock should be closed again or set for feeding in fresh stock, vacuum pulled on the still and several thousand pounds of fresh stock fed in. The still is fired and run for a short time, following the instructions given above for running down to tar. In this way the heavy, thick pitch is dissolved and thinned down with the fresh stock, and most of the latter is recovered in the subsequent distillation. While running down to tar the second time and before drawing same, the tar line should be blown out with steam to make sure that the line to the tar tank is open.

If the still is allowed to stand with thick tar in it, several days must elapse before the still cools sufficiently to work in it and then it is an extremely slow and tedious job to dig out the tar and clean the still and steam distributing system.

Filling Off Tar From Tar Tank

The tar can be drawn from the tar tank any time after several (5 to 6) hours' cooling. If fairly hard, care should be taken not to leave it in the tar tank so long that it will not flow freely. At a temperature of 300 to 350 deg. F. the tar will flow and not froth in the barrels or drums. The tar tank is provided with a small furnace in which a fire can be built to take the chill out of the setting and tank. The fire built under this furnace should at no time be greater than that obtained by burning one or two barrel staves. Too hot a fire may injure the tar tank, since there is no circulation on the inside. In other words, the fire is used merely to warm the setting and tank, to keep cold tar from building up in the tank, and not to attempt to heat the tar after same has cooled. This can be done only by running in a fresh batch of hot tar on top of the cold tar in the tank. The tar is usually filled into caustic drums or tight tierces. Barrels should be dry to prevent frothing and are usually whitewashed by rinsing with limewater to make them strip easily.

The gases given off by the hot tar in the tank are flammable, and together with the air in the tar tank form an explosive mixture. Therefore, do not use a red hot bar to open the passageway through the tar cock, should it become plugged. Use a warm bar, or close the tar cock and build a slow fire under the outlet nipple and cock until same are warm. Remove the fire before opening the cock. If for any reason the manhole cover is removed from the tar tank, no open flame or lantern should be brought near. Do not use air pressure in tar tank to force out the tar.

Double-Distilled Fatty Acids

The general instructions applying to the operation of the still in making single-distilled fatty acids apply to the operation in making double-distilled. The length of the run is, of course, considerably increased, since there is very little pitch (from 1 to 1½ per cent) obtained in running from single-distilled to double-distilled.

Preparation of Fatty Acids

In making double-distilled fatty acids, once-distilled fatty acids are fed to the still. As collected from the first distillation, the once-distilled fatty acids contain considerable moisture. This should be allowed to settle out in the storage tank and the clear fatty acids pumped to the feed tank, where they are heated and dried, as described for crude or "black" fatty acids.

The still is started up and operated in the same way as described above for single-distilled fatty acids. Eighty thousand to 200,000 lb. of good double-distilled fatty acids is collected before the distillate darkens to such an extent that it can no longer be classed or

used as double-distilled fatty acids. When this point is reached, the distillate is blown or pumped to the single-distilled fatty acid tanks, and at the same time the feed from the single-distilled feed tanks is shut off and crude or "black" fatty acids are fed to the still. The operation of the still is now continued as described above for single-distilled fatty acids until tar is drawn and the still steamed out.

When a battery of stills is operated, it is customary to reserve certain stills for making single-distilled fatty acids and other stills for making double-distilled fatty acids. In this case, when the distillate is no longer suitable for double-distilled fatty acids, the residue remaining in the still is drawn through the tar line into one of the stills running on crude fatty acids, and the still without any further steaming out is ready to be charged anew with single-distilled fatty acids.

The advantage of this procedure when a battery of stills is being operated is that the operator is assured that no hard pitch is at any time left in the stills which are used to make double-distilled fatty acids. It is to remove any such hard tar or pitch in the still that the steaming out of the still is done in accordance with the instructions given in making single-distilled fatty acids.

With proper control and operation, it is possible to run a still distilling double-distilled from single-distilled fatty acids continuously for a week before drawing the residue over to the "black" still. At times the distillate may show signs of darkening, and one or two eggs may have to be pumped to single-distilled storage, but by easing off on the firing temporarily or feeding in fresh stock, the distillate can be brought back to the proper color.

Yield of Distilled Stock

The yield of double-distilled fatty acids varies with the nature of the stock, with the manner in which the stock is handled and with the design and operation of the still. With fatty acids from acidulated cottonseed foots, the yield of double-distilled stock is about 85 per cent. About 12 per cent of pitch is obtained. Garbage grease fatty acids yield about 90 per cent double-distilled stock and 6 per cent tar. Other low-grade naphtha extracted greases will run slightly better than garbage grease, and pressed animal stock will give higher yields. The higher the split or saponification—that is, the less neutral oil left in the fatty acids—the higher the yield of fatty acids. The elimination of impurities by washing improves the yield. Proper design of still furnace, still and steam-distributing system is necessary to give maximum yield obtainable from a given grade of stock. The still must be operated with judgment and with careful, thoughtful attention to details. Air leaks throughout the plant must be avoided. Thus a high yield of superior color without offensive odor will be assured.

Grading Distilled Fatty Acids

For color reading the Lovibond Tintometer is most commonly used and the fatty acids are placed in a 1-in. glass cell. Fatty acids acceptable from the color standpoint as "single-distilled" will run 35 yellow, 7 red. Double-distilled fatty acids will run 35 yellow and 4 red. There are no universally accepted standards at the present time. In a plant operated in connection with a soap factory or a stearic acid plant the fatty acids produced are brought up to the requirements of the kettle or press room, and fatty acids distilled for sale are commonly sold on sample. In the earlier stages of a run double-distilled fatty acids will give a color test of 35 yellow and 2.5 red, or even slightly better.

Cost of Operation

The following costs were determined by the writer the early part of the present year in a two-still plant which had been recently installed and put in operation:

COST OF OPERATING TWO FATTY ACID STILLS

Material and Labor Cost:		
20-hp. water circulating pump motor, 50-hp. vacuum pump motor } at 2½c. per kw.	$1.33	
1,000 lb. steam per hour	.50	
300 lb. coal per hour at $4 per ton*	.60	
1 fireman	.45	
1 still man	.60	
1 helper	.40	
Cost per hour	$3.88	
Cost per 24-hour day		$93.12
Overhead, etc.:		
Depreciation per day on stills and equipment, total $55,000 at 10 per cent per year	$18.00	
Depreciation per day on building, $55,000 at 3 per cent per year	6.00	
Interest on investment—building, $55,000; equipment, $55,000; land, $8,000; total, $118,000 at 6 per cent	24.00	
Insurance at $150 per year, per day	.50	
Interest per day on inventory of $75,000 at 6 per cent	15.00	
Overhead per day		63.50
Operating and overhead per day, producing 24,000 lb.		$156.62
Operating and overhead costs per 100 lb. D.D.F.A.		.65

* Note.—The coal consumption was reduced to about 200 lb per hour, or about one-third, after the stills were insulated and the fireman became more experienced.

It will be noted that in this plant the cost of producing double-distilled fatty acids from crude fatty acids is 65c. per 100 lb. The writer knows of no reason why this cost should be any higher in any modern, properly constructed and operated plant. In the plant referred to all equipment is of the most recent and best design and, together with the installation and building, is of the very highest class.

Conclusion

In closing, it may be said that from the experience gained by the writer in designing and operating the many recent fatty acid plant installations, it has been possible to make very decided improvements. These apply not so much to the relatively simple basic principle of design, but rather to the perfection of numerous details which facilitate the uniformly smooth operation and proper control of the plant, centralize this control, eliminate unfavorable working conditions, simplify the duties of the operator, prevent damage to the equipment and make all parts of the equipment easily accessible.

The equipment must be substantially constructed so as to eliminate costly repairs and the more serious loss of output incident to shut-downs while making such repairs.

It is the desire of the still operator to obtain the highest possible yield of best quality distilled fatty acids at minimum cost. The writer trusts this paper may assist him in attaining that end.

German Trade With Santiago de Cuba

Imports of merchandise into the port of Santiago de Cuba from Germany in 1920 were valued at $275,231, and were principally hardware (tools, cutlery and aluminum ware), cement, beer pianos and toys, reports Consul Clum. Dutch vessels carried about 90 per cent, American vessels about 5 per cent and Norwegian vessels about 2 per cent of these imports.

Studies of Crystal Structure With X-Rays

Apparatus for Analyzing Atomic Spacing of Metals and Crystalline Powders, Brief Notes on Its Design, Operation and Interpretation of Results—Known and Potential Scope of the Method Is Discussed

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IT SEEMS conservative to predict that some very important data will soon be disclosed in the realm of physical metallurgy as a result of crystal study. While in no way encroaching upon the microscope—which has served to clear away much of the mystery surrounding the production of useful alloys and their subsequent mechanical and thermal treatment to develop desirable physical properties—the knowledge of the spacing and character of atomic arrangements in metals may find a more fundamental application.

With large and perfect crystals, the crystallographer has been able to give with surprising accuracy the form and angles of many materials. But metals are opaque and prone to exist as aggregates of polyhedral crystal grains whose contours bear no relation to crystal structure. Less has been accomplished in studying their internal structure except by the uses of X-rays developed by Laue and the Braggs.[1] Largely as the result of further development of this method by Hull,[2] St. John and others, it is not difficult now to study the crystal structure of almost any material.

Usually the metallurgist has not been inclined to follow out the complexities of X-ray diffraction and interference phenomena, and hence the work has been performed by physicists. But if the prospective investigator does not wish to devote the time necessary to a complete familiarity with the physics of the process, he still may be able to obtain end-results which he can utilize. If possible, he should become acquainted with the development of the method from the first "reflection" of X-rays by planes of atoms to the evolution of the present practices. But even if this is not practicable, he may accept the barest facts of crystal patterns and still derive useful information from his results. The splendid descriptive papers of Jeffries and Archer[3] in this journal should furnish him such understanding.

In the author's laboratory the method of Hull[2] is employed. Effort has been made at all times to simplify equipment to the utmost. Such simple devices as will enable the investigator to determine atomic arrangement will be described here.

SOURCE OF X-RAYS

A universal, broad-focus, molybdenum target Coolidge tube, operated from a high-tension transformer, supplies the radiation. Its connections are shown diagrammatically in Fig. 1. The X-rays may be regarded as a form of radiation differing only in frequency or wave length from Hertzian waves (wave length 10^6 cm. to 0.2 cm.), infra red (wave length 0.031 cm. to 7.7 $\times$ 10^{-5} cm.) visible light (wave length 7.7 $\times$ 10^{-5} cm. to 3.6 $\times$ 10^{-5} cm.), ultra violet (wave length 3.6 $\times$ 10^{-5} cm. to 5 $\times$ 10^{-6} cm.), or gamma rays (radium radiation, wave length 1.4 $\times$ 10^{-8} to 1.0 $\times$ 10^{-10} cm.). X-rays have been produced which overlap the range of the radium radiation.

On account of the general suitability of the dominant wave length, the lower voltage required and the absence of excessive penetration, the molybdenum target is chosen. For use with some specimens the characteristics of the rays produced by the tungsten target are very suitable, however. To permit use at high capacity the broad focus tube is chosen. To shorten exposures, the tube is run at limiting capacity and the sharp focus target would be locally overheated by the desired energy input. The sharp focus tube is chosen by the radiographer to give less confusion in his shadows, approximating as it does a point source.

The Coolidge tube is essentially a vacuum in which an electrically heated spiral filament supplies the available electrons which bombard a heavy target, maintained at a positive potential of several thousands of volts to the filament. This target emits X-rays of various wave lengths as a result of the electronic bombardment. The distribution of intensity in the different wave lengths is controlled by the potential maintained between the filament and the target—the higher voltage giving the shorter wave lengths. The intensity of any particular

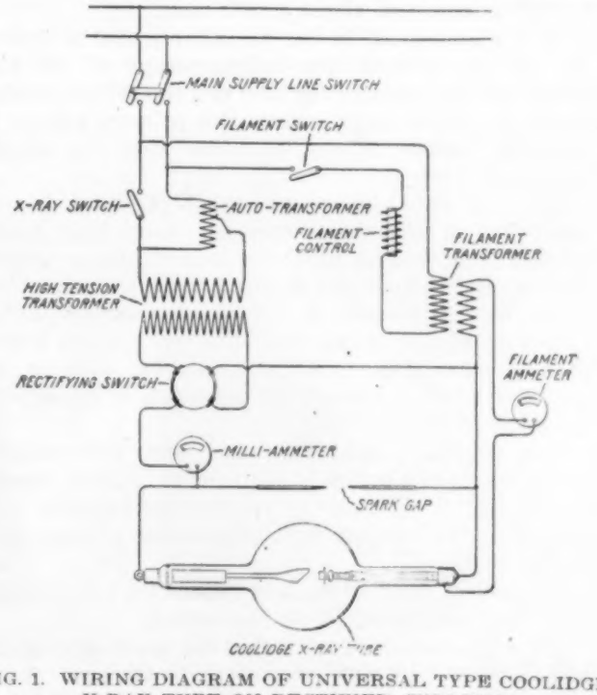


FIG. 1. WIRING DIAGRAM OF UNIVERSAL TYPE COOLIDGE X-RAY TUBE ON RECTIFIED CURRENT

[1] *Proc. Roy. Soc.*, 1913 and 1914; MET. & CHEM. ENG., vol. 15, p. 35 (July 1, 1916).
[2] *Phys. Rev.*, vol. 10, No. 6, December, 1917.
[3] "Atoms and Metals," vol. 24, p. 507, March 23, 1921. "The Crystalline Structure of Metals," vol. 24, p. 771, May 4, 1921.

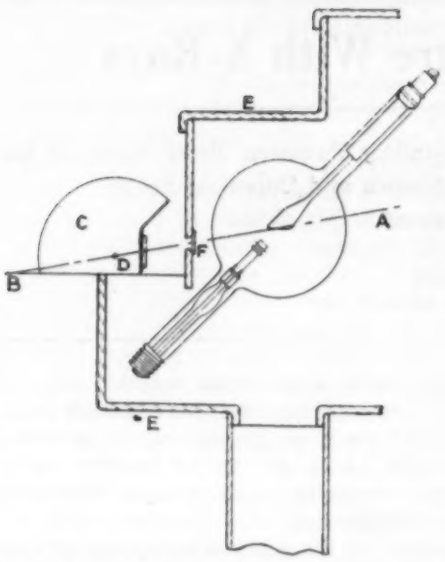


FIG. 2. DIAGRAM OF APPARATUS FOR CRYSTAL ANALYSIS

ray is controlled by the temperature of the spiral filament, and this in turn by the filament current.

The transformer should have a continuous capacity of at least 5 milliamperes at 40,000 to 45,000 volts. A small auto-transformer in the primary circuit controls the high-tension voltage. Rheostatic control is poorly suited to this type of work, but could be used with vigilant supervision. The filament may be heated by almost any steady source of 10 to 12 volts, current closely regulated by rheostat. The author finds a step-down transformer most convenient, employing a rheostat control on the primary.

The factor limiting the X-ray production is the heating of the glass comprising the tube. About 99.8 per cent of the energy of the applied wattage is transformed into heat, and in conducting this away the glass may give up traces of gas or even melt. A strong blast of air bathing the tube is very effective in raising its capacity. The author operates a tube continuously at 5 milliamperes and about 32,000 volts.

Meters are placed in the various circuits to indicate the filament current, the milliamperage of the high-tension circuit through the tube and the primary voltage across the transformer. From this primary voltage the potential backed up by the tube may be roughly estimated.

For moderate input the Coolidge tube is self-rectifying on alternating current. Very little inverse current is noticeable until the target reaches approximately the temperature of the filament, and this condition is not reached in continuous running without disastrous results to the tube. However, in the interest of accurate voltage control across the tube, a synchronous rectifier, though not essential, is conveniently placed as shown in Fig. 1.

Built-up mica preparations have been very useful as insulators in the author's equipment. Either tubes or plates may be obtained which can be adjusted to fit the contour of housing by bending under pressure while heated.

Complete installation and operating instructions invariably accompany X-ray equipment.

For crystal analysis a few thin flat beams are required and all other rays must necessarily be stopped. A complete housing of ¼-in. lead sheet accomplishes this very easily. It has been stated that even comparatively weak X-rays may be injurious to the human body after very prolonged exposure—so the safest scheme is to know where all the rays are emitted and arrange to absorb them positively.

Fig. 2 shows one of the author's outfits diagrammatically, and Fig. 3 is a photograph of the set-up. The target-face is horizontal, the axis of the tube at 45 deg. as shown in Fig. 2. The beams utilized (*AB*) lie on the surface of a flat cone springing from the target as apex, whose elements are at about 10 or 12 deg. to the plane of the target. Even the broad focus target under these conditions presents almost a "line-source" to the slits in the housing *C*. All slits for defining and screening the ray should be tapered—that is, smaller toward the source—to prevent the material of slit from scattering the rays, and thus interfering with the action of the beam on the specimen *D*.

To filter out and stop radiations of all but a narrow range—i.e., to secure monochromatism—Hull uses 0.35 mm. thickness of zirconia. The author uses a very pure sheet rubber as a filter into which the proper amount of zirconia has been compounded. The filter (*F*) must be placed on the inside of the screening slit, so that the latter will confine the scattered rays derived from the fluorescence induced in the filter. Zirconia is moderately transparent to the strongest molybdenum wave-length. Its fluorescence has furthermore dominant characteristic wave length (0.0690 Ang.) longer than the two shorter molybdenum lines, so that the latter are transformed into the characteristic zirconia wave-length and emitted in all directions. The screening slits prevent this general fluorescence from reaching the film. Fig. 4 shows the effect on a pattern of pure iron of filtering

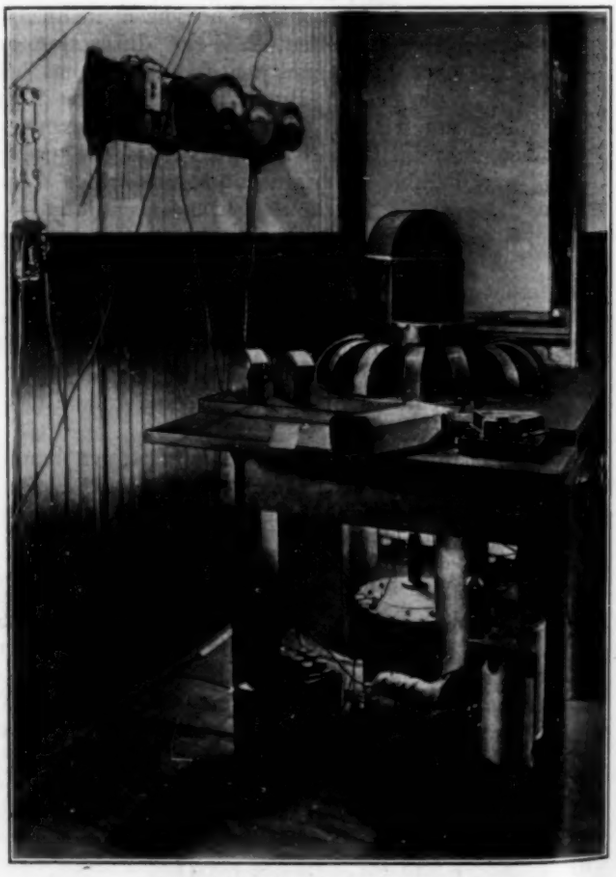


FIG. 3. ASSEMBLY OF APPARATUS FOR MAKING SIMULTANEOUS EXPOSURE

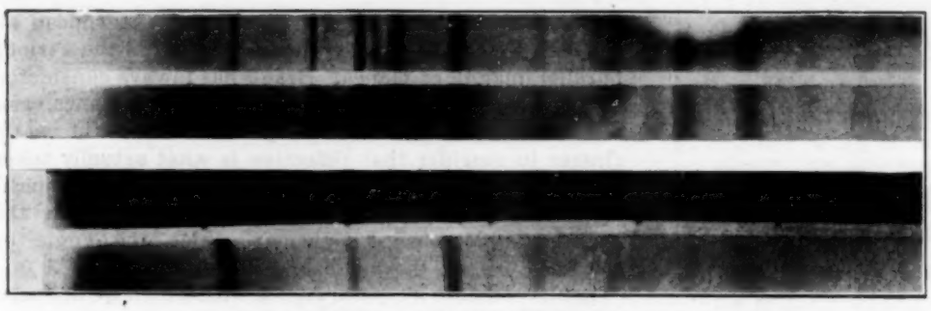


FIG. 4. SPECTROGRAM OF ALPHA IRON; WITHOUT FILTER ABOVE. WITH ZIRCONIA FILTER BELOW

for monochromatism. As a matter of fact, the molybdenum alpha ray which is used, 0.712 Ang.[1], is not strictly homogeneous, but is a mixture of two very nearly equal wave-lengths, and gives a double line with fine definition at a considerable diffraction angle. If recognized, this does not cause any ambiguity, however.

A form of screening slits is shown in Fig. 5. A wrought-iron pipe turned down and opened up supplied the material of construction. It is adjustable for width of beam, by means of the set screws shown.

An improved arrangement has been designed whereby the entire electrical equipment (tube and connections) is placed in a lead tank containing transformer oil, an arrangement which will more effectively protect the operator from accidental shock from contact with high-voltage conductors.

As will be shown, the specimen must lie at the center of a circular film. Therefore the author has built all film holders with a rigid specimen holder as an integral part. Rigid stops against which the specimen is pressed by springs keep the alignment very accurate at all times.

Two types of holders are shown in Fig. 6. The one at the left has the specimen well inside the film holder and permits use of a longer film. Also the holder is divided so that two patterns may be recorded simultaneously on one film for close comparison. The other type has an exposed and easily accessible specimen holder. Aluminum sheet 0.007 in. thick is fitted to the holder in the arc of the circle; this provides a smooth resting place for the film and serves to filter out any soft rays (long wave-lengths) which may be produced by fluorescence of the sample or filter, and tends to give a more "contrasty" film. The film is conveniently placed in a black opaque paper envelope.

The author finds the duplitized film most sensitive. A sheet of Patterson special intensifying screen is placed in the envelope on the side away from the specimen. This screen transforms much of the rays not absorbed in the film—which would otherwise be lost—into actinic light, which in turn acts upon the film to record the pattern and greatly shortens the time of exposure. Two strong rubber bands encircling the whole film holder serve to maintain a very intimate contact between film and intensifying screen—a most necessary condition.

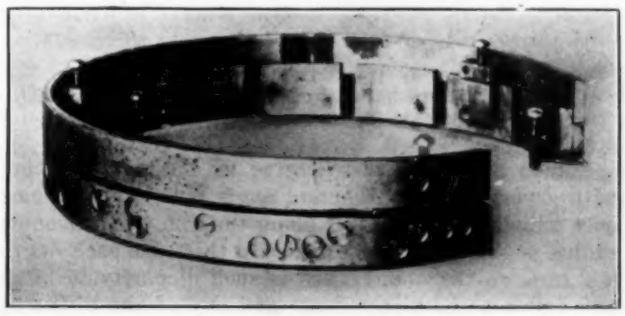


FIG. 5. SERIES OF SCREENING SLITS

Before considering the details of apparatus further, let us see what happens to the beam as it strikes the specimen. Fig. 7 very crudely represents the diffraction of a pencil of X-rays directed upon a conglomerate of many tiny crystal units. As we desire only to measure the angles of the several diffracted beams from the main beam, we do not need to record the whole circles. If we place a narrow film in the arc of a circle about the

[1] The Angstrom unit of length (10^{-8} cm.) is a most convenient one for X-ray wave-lengths and atomic spacings.

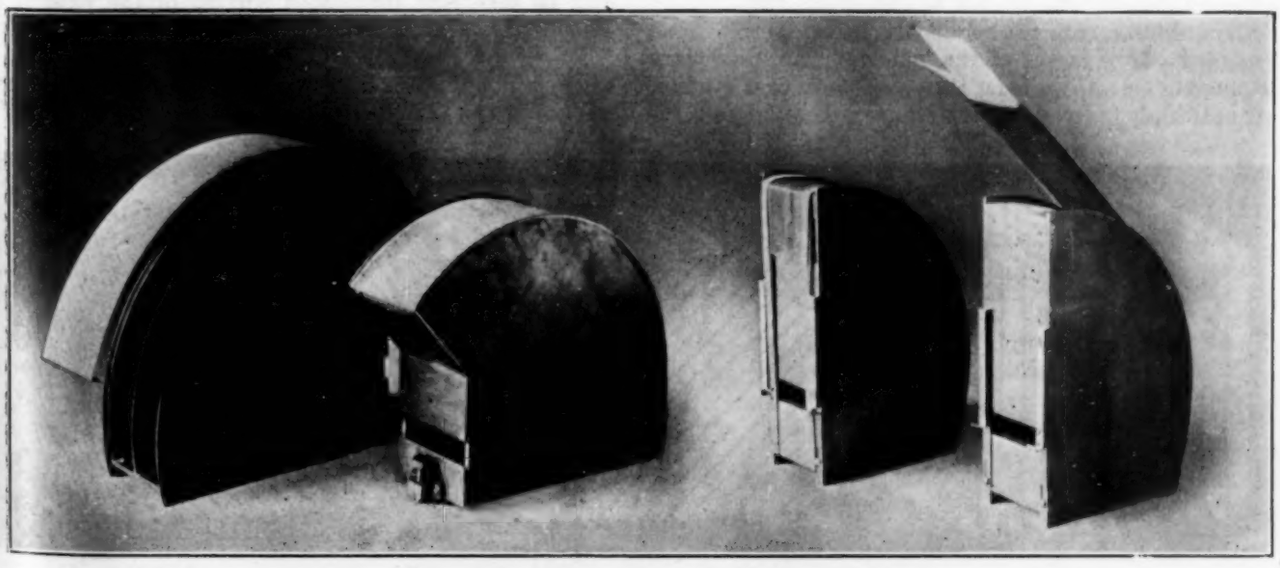


FIG. 6. TWO TYPES OF SPECIMEN HOLDERS

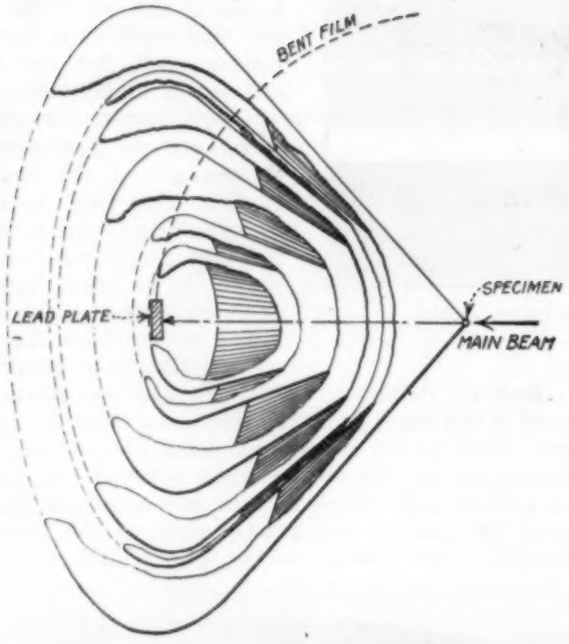


FIG. 7. CONES OF RAYS DIFFRACTED FROM A FINE GRAINED SPECIMEN (CUBIC FACE-CENTERED SYSTEM OF CRYSTALLIZATION)

specimen as center, it will give us conic intersections with a very slight curve, and angle estimation becomes only a linear measurement along the film. A convenient radius is 114.6 mm., or $4\frac{11}{16}$ in. In this case each degree is 2 mm. on the film. There is such disparity in intensity between the direct beam and any of the diffracted beams that enormous halation would result on the film if some means were not employed to cut down its intensity. This is accomplished by interposing about 0.025 in. of lead. It should not exceed about $\frac{1}{2}$ in. at the most in width, lest it obliterate some of the pattern. The main beam should then register with intensity comparable to the reflected lines.

With this set-up a 24- to 36-hr. exposure will yield a film which will show black lines—such as in Fig. 4.

The mechanism of the diffraction of X-rays has been described frequently and the reader is referred to Braggs' "X-Rays and Crystal Structure"; Chapter 13, "X-Rays," by G. W. C. Kaye; and A. W. Hull's paper in *Physical Review*, vol. 10, No. 6, December, 1917.

Crystallinity requires regularity in the spacing and grouping of the atoms of the material. As a corollary to this statement, we must then be able to pass systems of uniformly spaced parallel planes, through all the atoms, or atomic groups, in a crystal, and indeed all the data we obtain are the distances between the various parallel imaginary planes. Bragg has always considered the X-rays as being reflected from these planes, and while diffraction creates the phenomenon it is vastly clearer to consider that reflection is what actually takes place. When a system of parallel planes is in a position to reflect the X-rays, it is done precisely like the specular reflection of light, in which the angle of incidence equals the angle of reflection.

Let us consider a crystal lattice with which we are very familiar, and termed the simple cubic arrangement. Rock salt, silver chloride and calcium oxide are examples of this structure. If imaginary elementary cubes be piled regularly, at each cube corner we have an atom. Three of the possible systems of parallel planes passing through all atoms of the crystal are shown in Fig. 8. The first is composed of the cube face planes—the distance between planes will be our unit. Evidently there are three planes of this sort which are indistinguishable, corresponding to the directions of the three axes of symmetry. In the second (middle) we have passed planes through one of the six possible directions containing the diagonal edges of cubes. The spacing is $\frac{1}{2}\sqrt{2}$ times the distance between planes shown to the left, and the planes are those described by Miller as the 110 plane. At the right we have passed the 111 planes, the distance apart is $\frac{1}{3}\sqrt{3}$. We could continue passing planes through the atoms until the spacing would be very thin indeed. These spacings—it is interesting to note—would continue in a series 1, $\frac{1}{2}\sqrt{2}$, $\frac{1}{3}\sqrt{3}$, $\frac{1}{4}\sqrt{4}$, $\frac{1}{5}\sqrt{5}$, $\frac{1}{6}\sqrt{6}$, $\frac{1}{8}\sqrt{8}$, $\frac{1}{9}\sqrt{9}$, etc., with only a few omissions, notably $\frac{1}{15}\sqrt{15}$.

The condition for obtaining reflection from the atomic planes is that the wave fronts originating from all atoms encountered shall be in phase, giving in effect a nearly plane front on the reflected wave. In the diagram, Fig. 9, we have this condition existing for two wavelets also having a plane wave-front, and we may derive the formula representing the relation of wave-length λ, plane spacing d and reflection angle θ. To produce a minimum of interference when the beam is reflected from two consecutive planes, the total added length of path for the second plane must be an exact wave-length or a multiple of it. From the diagram it may be seen that this added portion of the path is $d \sin \theta$ before, and the same after reflection. Hence

$$n\lambda = 2d \sin \theta$$

where n is any integer representing the order of interference. This is the fundamental equation.

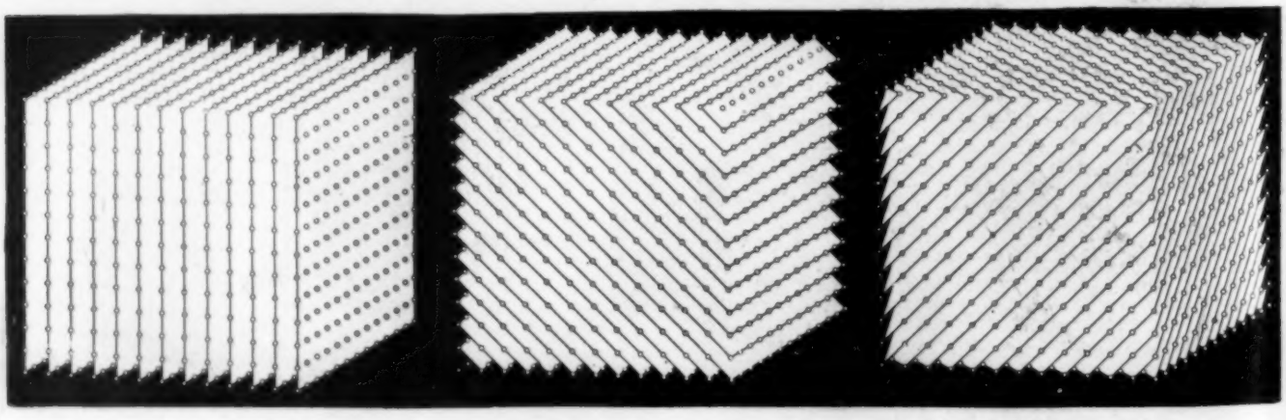


FIG. 8. THREE SYSTEMS OF PARALLEL PLANES THROUGH CUBIC ARRANGEMENT OF ATOMS

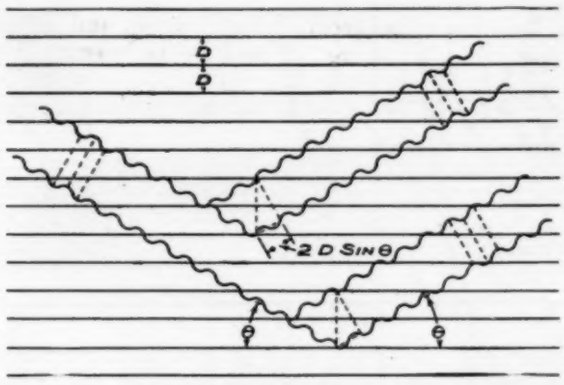


FIG. 9. REFLECTION OF TWO WAVELETS

The correct angle relations for the first three lines of a simple cubic structure of 1 Angstrom size produced by X-rays of 0.712 Ang. are shown in Fig. 10.

Obviously with a narrow monochromatic beam only one line can be reflected from one crystal at a time. But if this crystal could be rotated into every conceivable position we should obtain reflections from every plane spacing possible within the limits set by the fundamental formula. Sin θ cannot exceed 1, hence when the spacing between atomic planes is less than one-half the wave-length we obtain no reflections. Although the early investigators carefully rotated a single crystal to obtain the measure of the various possible spacings, it is much simpler to obtain many lines from metal simultaneously by a chaotic mixture of many tiny crystals. Such an aggregate will present crystals to the rays in almost every conceivable orientation, and like planes similarly placed in various parts of the mass will co-operate in intensifying the waves reflected.

A fine-grained metal gives a good distribution of smooth lines on the film, while a coarse grained structure is spotted and shows dashed lines, as would be expected. Some months ago the author undertook a study of this phenomenon to obtain a method for grain size determination in materials for which the ordinary method of microscopic examination is inadequate.

The deciphering of a pattern on the film as complex, say, as the one for cementite (Fe_3C) represented in Fig. 11 might well seem impossibly difficult. The method used, of course, it to build up a crystalline lattice whose distances from atom plane to atom plane are such as those indicated by the pattern. The "cut and try" method is the one forced upon the investigator in a large measure, but some circumstances ameliorate this hopeless prospect. The worker in metals finds a very few crystal habits; these are largely in the cubic system, together with a few hexagonal and tetragonal arrangements. Furthermore, Hull and Davey have added to the convenience of interpreting films by preparing a number of diagrams which show the atomic distances for a large number of possible lattices.[5] For instance, Fig. 12, reproduced from their paper, shows the spacings for a face-centered tetragonal crystal having all possible ratios of horizontal to vertical axis between 0.1 to 1.5. It may be noted in passing that the body-centered and face-centered cubes occur on this diagram, since a face-centered tetragonal crystal with axial ratio of 0.707 corresponds to the former and an axial ratio of 1.0 to the latter.

The scale of abscissas is logarithmic, so that if the ratios between plane spacings be figured from the exposed film and plotted on the scale at the bottom of the plot, they may be compared directly without regard to the absolute dimensions. In Fig. 12 a strip of paper bears such a series of lines derived from powdered indium, and by trial it is seen to fit well into the position shown, from which it is inferred that it crystallizes in the face-centered tetragonal system, very close to cubic but elongated 6 per cent in the direction of its principal axis. Such, in brief, is the method which allows determination of crystallinity.

It may be seen now that the preparation of the sample is of great importance. For accuracy a small thread of the material about 1 mm. in diameter is preferable, but for many determinations a flat surface of cast or powdered metal placed a few degrees to the beam is desirable. The results are nearly identical whether the surface reflections are obtained or whether the pattern is made up of the deeper reflection from a transmitted beam. The criterion is the absorption of rays by the material. "Shooting through" is desirable for materials of low atomic weight, but specimens of high atomic weight sufficiently thin for this method are difficult to produce.

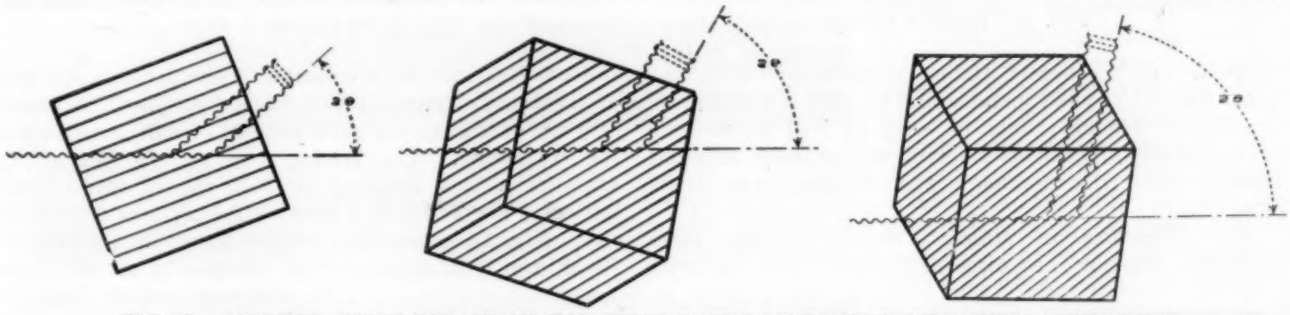


FIG. 10. CORRECT ANGLE RELATIONS FOR FIRST THREE LINES OF SIMPLE CUBIC STRUCTURE

If the surface is inherently different in nature from the interior, the superficial reflection may be misleading; naturally oxide is to be avoided.

Powdered crystals should pass a 200-mesh screen; some materials thus finely divided still produce spots in the film. Some materials when powdered show a great tendency toward packing into a favored orientation; for instance, graphite is a notorious offender. The author mixes such materials in heavy shellac solution and stirs up the paste, which subsequently dries without any tendency to orient itself selectively. Such tiny

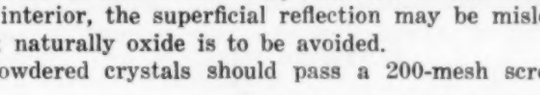


FIG. 11. REPRESENTATION OF THE FIRST FEW LINES ON THE CEMENTITE PATTERN

[5] "Graphical Determination of Hexagonal and Tetrogonal Crystal Structures From X-Ray Data."

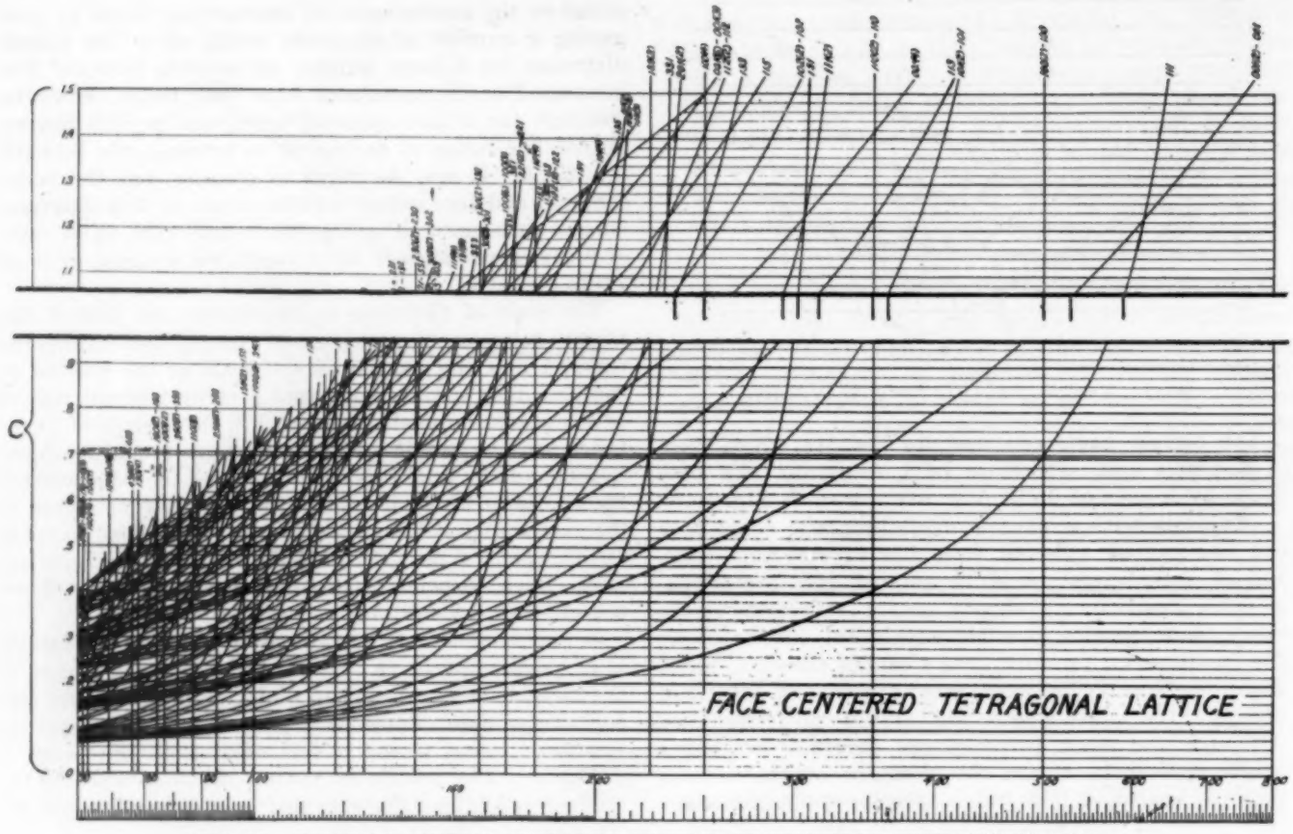


FIG. 12. INDIUM PATTERN COMPARED WITH FACE-CENTERED TETRAGONAL PLOT

briquets are frequently strong enough to use in the same manner as solid metal would be used. As small an amount of binder should be used as will adhere the mass, for any amorphous material will produce sufficient random scattering to cause a general blackening of the film.

The difference in atomic volume between some materials cannot be discerned from the patterns obtained, and indeed they may conceivably be identical. Thus tungsten and molybdenum are just sufficiently different to give patterns which with fine definition do not coincide. An austenitic manganese steel pattern is indistinguishable from the pattern of nickel. But in most cases the pattern is absolutely characteristic of one substance. Hence here is a qualitative analytical method of wide application.

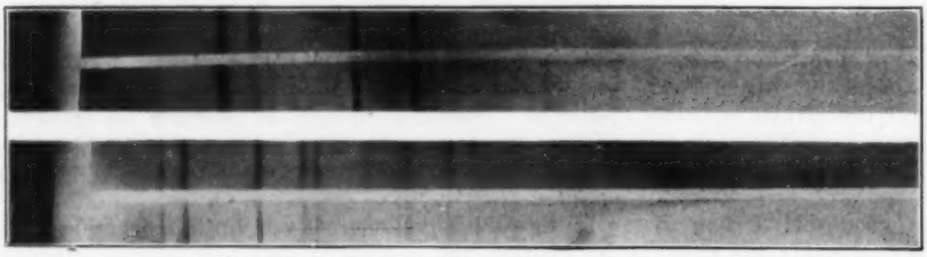


FIG. 13. PATTERN OF METALLIC SILVER (ABOVE), COMPARED TO PATTERN OF SILVER CHLORIDE (BELOW); SHOWING EFFECT OF DIMENSIONS IN SPACE LATTICE

The applications of the method will not be discussed in this paper, but the behavior of some types of substances will give some idea of the problems which may find a solution in crystal structure study.

In the case of compounds it so happens that very often the lighter atoms are unable to "interfere out" the less divergent lines resulting from the wide spacings of the heavier atoms alone. Thus with AgCl we obtain only the face-centered cubic pattern of half the atoms in the compound. The reader may satisfy himself by visualizing two interpenetrating face-centered cubic lattices. The result is a simple cubic system of half the size. Fig. 13 shows this pattern along with elemental silver, and it is apparent that the spacing of the planes in elemental silver bears a fixed relation to the planes of silver chloride. In a good film there is a faint trace of the simple cubic pattern superimposed upon the face-centered pattern of the heavier material. With salts in which the atoms are of similar atomic weight such as NaF, KCl and MgO, the simple cubic pattern is dominant and only a faint trace of the pattern of the like atoms shows.

Fig. 14 shows comparatively the patterns of three closely related lattices of the cubic system. It is interesting to note that in all the cubic patterns obtained the versines of the angles on the film (not the half angles) bear an integral relation to one another. This becomes more obvious when one recalls the relation $\sin^2 \theta =$

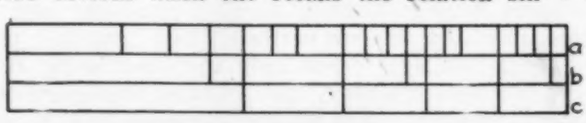


FIG. 14. PATTERNS FROM THREE CLOSELY RELATED CUBIC LATTICES

a—Simple cubic; edge = 2.55 Ang. *b*—Face-centered cubic; edge = 2.55 Ang. *c*—Simple cubic formed by two face-centered lattices of size *b*, the new arrangement having edge = 1.275 Ang.

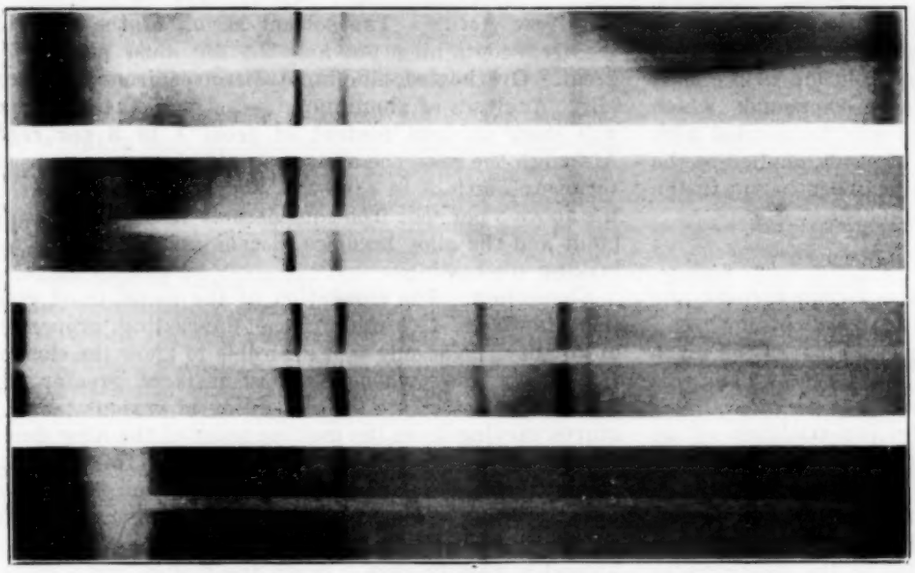


FIG. 15. NICKEL PRESERVED IN ITS SOLID SOLUTIONS
a (above)—Pure nickel. *b*—40 : 60 nickel : chromium. *c*—30 : 70 nickel : iron.
d—50 : 50 nickel : copper.

$\frac{1}{2}$ (1 — cos 2θ). In the cubic system sin θ is proportional to the square roots of certain integers, as was mentioned in a previous paragraph. Thus this function in the face-centered pattern forms the ratios 3, 4, 8, 11, 12, 16, 19, 20, 24, 27, 32, 35, 36, 40, etc.

In the case of mixtures, the method yields a film

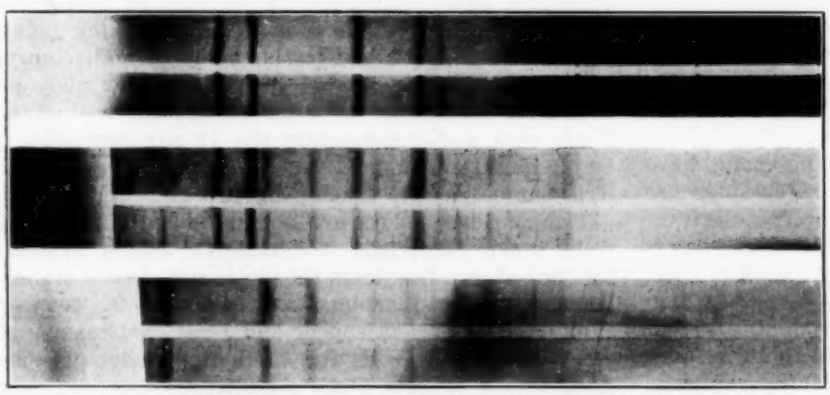


FIG. 16. ALUMINUM (ABOVE), SILICON AND THEIR EUTECTIC

which contains the characteristic lines of both materials. For reasons which are too involved for discussion some materials give weak lines with exposures that produce strong lines with other materials. Hence in mixtures we may find a great disparity in the intensity of the two patterns, which cannot be accounted for by the proportions present. However, in the case of mixture of similarly reflecting substances, the relative intensity is a fair measure of constitution. The author has been able to secure a strong pattern from a constituent which made up only about 9 per cent of the volume of the specimen and very weak lines from considerably lesser proportions. On the other hand, one material which appeared to occupy about 40 per cent of the volume yielded no visible pattern. As a method of quantitative estimation the method holds little hope.

In Fig. 15 we may see that the lattice of nickel has not been changed by the addition of 70 per cent iron, 40 per cent copper and 60 per cent chromium. It seems likely therefore, at least in the case of metals having limited solubility in the solid, that the atoms of solute simply replace up to a certain proportion of the atoms of the solvent in more or less uniform distribution without materially distorting the lattice. Presence of additional solute creates a new phase—a new crystal lattice consisting of intermetallic compound or the solute element itself containing in its lattice more or less of the solvent. If the second phase is capable of existing with composition overlapping the limit of the first, we say there is complete or continuous solid solution such as Cu:Ni or Ni:Cr.

In the case of some continuous solid solution types of binary alloys, the author was able to show the presence of two crystal lattices existing simultaneously, exactly as would be expected from certain compositions and heat-treatments. Presumably at higher temperature one of the forms might entirely disappear.

Eutectic mixtures usually show coarser grain characteristics for the pattern of one of the constituents than for the other. Fig. 16 shows the eutectic of aluminum and silicon and a faint trace of the cementite is revealed in the white cast iron of Fig. 17.

Probably one of the most striking uses of the method is the determination of allotropy. The verification of the allotropy of iron and cobalt attracted the author immediately. There is no mistaking the difference in pattern of alpha and gamma iron represented in Fig. 18.

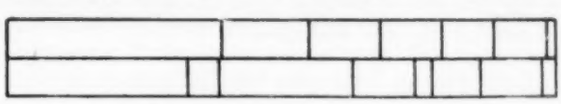


FIG. 18. PATTERNS OF ALPHA IRON (ABOVE) AND GAMMA IRON

Some metals severely worked in one direction produced films in which the lines corresponding to one or more spacings are extremely weak. This is due probably to the persistence of favorably oriented grains and hence a predominance of certain spacings in the beam from a particular direction.

Judging from some preliminary tests, it seems possible that some light may be thrown

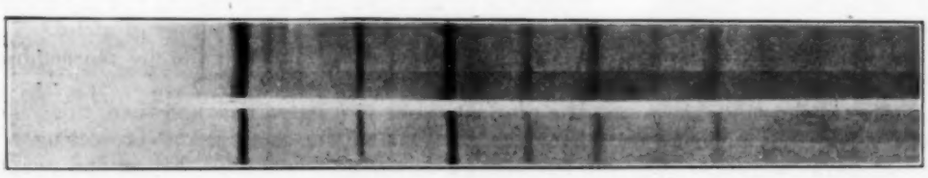


FIG. 17. WHITE CAST IRON

upon the matter of the unusual embrittling of certain metals observed when they are subjected to nascent hydrogen or when plated out from solution in the cold. The actual number of intermetallic compounds which exist in the copper-tin-zinc series may be verified with comparative ease by the method of study applied to the problems mentioned. This work has been begun in the spectrometers of the author's equipment.

Unnoticed Potentialities

To one who reads critically, the incompleteness and superficial character of this account will be apparent. The possible applications of the method have been much more attractive than refinement of the process, and this fact is by no means concealed in the description. One cannot but be impressed by the potentialities of an implement of research so "fine-grained" that it reveals the mode of association of the atoms themselves. With this in mind it is perhaps not surprising that illuminating information regarding the allotropy of iron and the hardening of steel has been yielded by the spectrometer in the few months since its design and installation in the author's laboratory. At any rate this comparatively new line of attack upon problems of physical metallurgy bids fair to produce some of the next set of answers to the interminable questions "how" and "why."

Notes on Aluminum Die-Castings

By F. A. Livermore

DIE-CASTING may be defined as metal castings made by forcing molten metal under pressure in a metallic mold or die. It is necessary to keep this definition in mind to avoid confusing this process with other permanent mold-casting processes.

Only alloys of comparatively low melting point have been successfully die-cast but the finished castings are extremely accurate and free from all irregularities. Aluminum die-castings not exceeding 1 in. in any direction can be cast with an accuracy of 0.0005-in., the resultant castings possessing smooth surfaces which can be polished without intermediate machining.

Die-castings in aluminum weighing 30 to 40 lb. each are now being turned out in considerable quantities. Aluminum pistons and other parts for automobile and airplane engines have been made, which are subject to severe strain at high temperatures when the tensile strength of the metal is generally very poor. Such castings would have a strong tendency to brittleness but for the characteristic high thermal conductivity as compared with iron and steel.

Suitable Dies and Die-Casting Alloys

In the first attempts to die-cast aluminum the problem of obtaining a suitable die material presented serious difficulties. This problem, however, has been solved by the use of various alloy steels. The proper gating and venting of the dies are also problems that arise daily, and on the solution of these problems depends largely the success or failure of the operation. Chromium:vanadium steel is generally used, although in some cases cast-iron dies are used for castings of simple design.

Just what constitutes a good die-casting alloy is a subject of unusual interest; a few of the important requirements outside of the usual physical properties demanded of alloys are:

Solvent Action. The solvent action of the alloy on the iron containing pot and the die must not be too great. Overheated aluminum dissolves iron very rapidly. Analyses of aluminum die-castings on the market will show an iron content of from 1 to 3 per cent. Although the presence of iron in aluminum presents no serious objections in sand-cast alloys, the absorption of the above 3 per cent iron considerably raises the melting point and the alloy becomes viscous and unsuitable for making die-castings.

Elongation. The elongation of the metal is of vital importance in determining the die-casting properties of an alloy. Not only is it desirable to know the elongation of an alloy when cold, but it is of greater importance to determine the elongation at various temperatures varying from the melting point of the alloy down to normal temperatures. The reason for this becomes obvious when the physical phenomena of the die-casting process are considered. Let us assume that a ring 12 in. in diameter is to be die-cast in a metallic mold around a metallic core. When the molten metal comes in contact with the mold it changes state, solidifies, which is accompanied by a shrinkage in volume. The metallic core, not being compressible, retains its size and form, so that the die-casting is subject to a "stretching" action and if the ductility of the alloy at this temperature is not high enough to withstand this strain, the casting will crack.

It is well known that the addition of a "hardener," say copper, reduces the elongation of aluminum. An aluminum alloy containing 12 per cent of copper will show less elongation than an alloy containing only 6 per cent of copper when testing it at normal temperatures. Nevertheless the 12 per cent copper alloy has a greater elongation at high temperatures than the 6 per cent and consequently the 12 per cent alloy is better able to withstand the casting stresses to which it is subject in the die-casting process.

The zinc-base alloys are not suitable for casting in metal molds (especially if commercial spelter is used), for they absorb iron from the molds and show a striking tendency to hot-shortness. An alloy of 92 per cent aluminum, 7 per cent copper and 1 per cent manganese gives very good results for die-casting under pressure, since this alloy sets forth a practical compromise between the antagonistic requirements of low melting point, high tensile strength and ductibility at temperatures just below the point of solidification.

Die-Casting

The metal to be die-cast is melted in the furnace crucible and the temperature of the furnace regulated by means of a pyrometric installation, so that the alloy is kept at a uniform temperature about 10 deg. C. above the melting point of the alloy.

The assembled dies are heated to about 500 deg. F. (260 deg. C.) and fixed over the nozzle of the machine. The sprue-cutting bar is released back, thus opening the nozzle, and the metal molten is forced into the dies by air pressure.

When the mold is full the sprue-cutting bar is brought to position, thereby cutting off the supply of metal. The die is opened, the casting removed, the die reassembled and the operations are repeated.

The dies should be lubricated now and then, this facilitating the removal of the casting and protecting the die surfaces; a mixture of lard-oil, beeswax and graphite is used for this purpose.

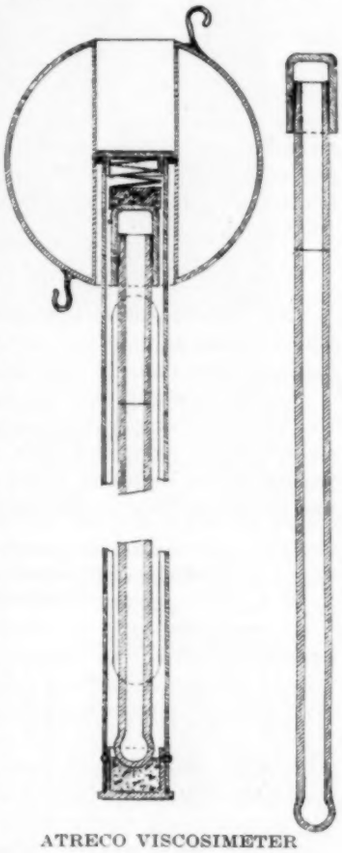
Air Bubble Viscosimeter

By Victor R. Abrams,* Joseph T. Kavanagh† and Charles H. Osmond§

THE principle that a restricted air bubble, confined within a tube of definite small diameter, will move upward by influence of gravity through a mass of oil, the action being duplicate under identical conditions, and that this rate is a function of the viscosity of the oil, has been applied in the construction of a compact, portable type of viscosimeter.

This viscosimeter, named by the authors the "Atreco" viscosimeter, requires only a very small quantity of oil for operation, is capable of rapid manipulation and has an experimental error no greater than that obtained with the Saybolt Universal viscosimeter.

The instrument consists of a piece of glass precision tubing, 21 cm. long with an internal diameter of 5.2 mm. One end of the tube is sealed by blowing thereon a bulb of spherical shape about 8.5 mm. in internal diameter. The opposite end is ground with a slight taper and a cap is made to fit thereon. By grinding the cap on the end of the tube an air-tight contact is made. Previous to this grinding, a small hole is made through the side of the cap for overflow when filling with oil. A "V" shaped groove is cut in the cap end of the tube to act as a trough, for outflow in conjunction with the small hole in the cap. By grinding off the end of the tube, air space in the cap can be modified, until proper size of bubble is obtained. It has been found that an air chamber which will produce a bubble 17 mm. long ± 2 mm. is very satisfactory. Two lines are etched or engraved around the external circumference of the tube, about 10 cm. apart, with the included space at the middle section of the length of the completed tube.



ATRECO VISCOSIMETER

The tube, after being thoroughly cleaned and dried, is filled with the oil to be tested. The cap is adjusted so that the hole in its wall is over the overflow trough in the tube. The tube is now immersed in a water bath at the desired temperature of the test, allowing the cap to be above the water level. The oil will expand and escape through the overflow trough and hole. When no further expansion is noted, the cap is turned, thus sealing the tube with its contents of oil and air. The tube is then placed within its holder (see illustration) and the entire instrument is placed in the water bath. This bath should be in the form of a glass cylinder, so that the instrument is plainly visible when looking through its walls. The water bath should be maintained at the desired temperature of the test.

Invert the tube, thus allowing the bubble to rise. This first run is not recorded. As rapidly as possible make five determinations by inversion of the tube after each one, making sure that the bubble has traversed the entire length of the tube. The determination is made by observation of the number of seconds and fractions thereof that elapse between the passing of the bubble from one line on the tube to the second line, care being taken that the notation is always made at the same point of the bubble. The average of these five determinations, when multiplied by the factor governing the calibration of the tube, will give the Saybolt Universal value (seconds) of the oil at the desired temperature. The bath must be maintained at this temperature for accurate determinations.

Calibration

The Atreco viscosimeter is calibrated in the following manner: A duly certified standard Universal Saybolt viscosimeter is used to obtain the viscosities of a group of oils ranging from 80 to 475 seconds Saybolt at 100 deg. F. Check runs are made of each oil until a Saybolt Universal value is obtained that can be considered accurate. Care must be taken in standardizing oils on the Saybolt instrument not to re-run the same sample, as it has been found that if the same oil is re-run a number of times, the values obtained may vary considerably. The retained samples are then tightly sealed until ready for use in standardizing the Atreco viscosimeter. The tube of the Atreco viscosimeter is now filled and the oil expanded at a temperature of 100 deg. F., as noted in method of operation, the surplus oil being forced out through the opening in the cap. The cap is adjusted to seal the tube and the tube is placed in the metal holder or container for convenient and accurate form of suspension; the instrument is immersed in a water bath kept at 100.25 deg. F. and allowed to remain a few minutes for the purpose of stabilizing temperature. The instrument is now inverted, thus causing the bubble to rise. The first run is not recorded, being made to allow the oil to wet the internal wall of the tube thoroughly. Five runs are now made (by inversion of the instrument), measuring the exact time required for the same point of the air bubble to travel from one mark to the other. The exact average of the five runs in seconds is taken as the true time. This average result divided into the Saybolt Universal viscosity gives the factor of the instrument.

For accuracy, it is advisable to take four oils with respective viscosities of 90, 130, 230 and 475 Saybolt seconds at 100 deg. F. and obtain the resultant factors. It will be noted that the factors so obtained will agree to within a few hundredths, a variation liable to experimental error. These facts apply to tubes within the dimension limits given and will show deviations as hereafter noted when other size tubes are used.

This method of calibration has proved thoroughly practical and results obtained are within the range of accuracy claimed for the instrument. The use of distilled water as a calibrating liquid is not practicable.

As shown in Table II the presence of adulterants produces no effect on the usefulness or accuracy of the instrument. It will be noted that results show deviations of approximately 0.5 per cent. and it is believed

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that by using ordinary care and technique, variations should not be more than 1 per cent of the Saybolt Universal outflow time on oils of viscosity not less than 80 seconds Saybolt Universal.

It was suggested by J. M. Maris that a pocket type viscosimeter might be developed by the application of Stokes' law, which relates to the movement of an unrestrained sphere in a mass of fluid. This was found impracticable after study, confirming results obtained by Prof. Mills in the study of measurement of viscosity by use of an air bubble. Thus the restricted bubble type of instrument was developed.

Limitation of the Internal Diameter of the Tubing

The first point of consideration, after experimentation had demonstrated that a restricted bubble could be used for definite determinations, was the internal diameter of the tubing. Precision tubing was found essential for accurate results. Tubing with an internal diameter of from 3.0 mm. to 7.0 mm. was tried, but it was found necessary to limit the internal diameter to 5.0-5.6 mm. in order to operate practically with both high and low viscosity oils.

TABLE I. CALIBRATION OF ATRECO VISCOSIMETERS FOR THEIR SAYBOLT FACTOR

		Tube 1 *Length, 10 cm. Diameter, 5.2 mm. Length of bubble, 17 mm.		Tube 5 Length, 9.4 cm. Diameter, 5.15 mm. Length of bubble, 17 mm	
Oil	Saybolt Sec.	Time, Sec.	Factor	Time, Sec.	Factor
1	86.8	8.4	10.33	9.6	9.04
2	145.6	14.1	10.32	16.2	9.00
3	229.0	22.2	10.31	25.5	9.00
4	475.2	46.1	10.31	52.7	9.02
		Tube 18 Length, 9.95 cm. Diameter, 5.2 mm. Length of bubble, 17 mm.		Tube 19 Length, 9.95 cm. Diameter, 5.3 mm. Length of bubble, 17 mm.	
		Time, Sec.	Factor	Time, Sec.	Factor
5	92	7.9	11.64	7.3	12.60
6	146.6	12.6	11.63	11.6	12.63
7	234.6	20.1	11.66	18.5	12.68
8	475.2	40.8	11.64	37.6	12.63

* Length distance between etched lines.

The final procedure was the selection of a proper sized tube to give a definite relative value to the Saybolt viscosity. Many trials were made with tubes of the following internal diameters: 5.0, 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6 mm., using the same length of bubble and under as nearly identical conditions as possible.

Results showed that the tubes with an internal diameter of 5.0 and 5.1 mm. had factors which decreased as the viscosity increased; tubes with an internal diameter of 5.4, 5.5 and 5.6 mm. had factors which increased as the viscosity increased, but tubes with an internal diameter of 5.2 and 5.3 mm. had factors which produced results differing by not more than the experimental error.

The limits for the internal diameter of the tube were therefore determined to be 5.2 and 5.3 mm. A tube of internal diameter within these limits gives variations which compare with Saybolt variations for the same oil, thus yielding values which may be converted into Saybolt seconds by use of a constant factor for each tube. The time of operation of a tube of this diameter is neither too short for accuracy nor too long for convenience.

The middle section of the glass tube was chosen for observation to eliminate possible end effects and to allow sufficient time for the bubble to assume a constant condition.

The end of the tube was blown with enlargement, corresponding to the cap end, in order to retard the bubble and thus permit sufficient time for proper observation.

Constant volume of the bubble is obtained by provision of the overflow at cap end of the tube and through the small hole in the cap. This constant volume was considered necessary for proper operation.

Observation of a tube in operation shows that the passage of the bubble upward is made possible by the displacement downward of a volume of oil equal to the cross-sectional area of the bubble times the distance swept through. This displacement takes place as an annular flowing film surrounding the bubble and produces a capillary corresponding to that in a short tube viscosimeter. As far as can be observed this capillary film is of uniform thickness for any definite condition when the tube is in a vertical position, but its uniformity is rapidly destroyed and the movement of the bubble accelerated by any small variation from the vertical.

Table I shows the results obtained in the calibration of four separate Atreco viscosimeter tubes for their Saybolt factor. Table II shows typical results obtained, using four separate instruments and a number of oils covering a Saybolt viscosity range of 90 to 476 at 100 deg. F.; the error in seconds between the actual determination and the factor determination; the absence of any effect upon the results when mineral oils containing adulterants, such as may be used in compounded oils, re tested.

Uses of the Instrument

This instrument is applicable in a number of cases where small samples of oil only are obtainable. The average tube requires for operation about 4 c.c. of oil.

Another use for this instrument is the obtaining of the viscosity-temperature curve of an oil in a relative short time as compared with the usual method. As the results of the Redwood, Engler and Barbey instruments are all convertible to the Saybolt values, it can readily be seen that a conversion factor may be determined to give results comparable to any of these instruments.

There is also the possibility of the use of the Atreco instrument in the field, or where the laboratory methods are not possible or practical. In this case the bath would be eliminated and the reading made at air temperature. The viscosity as obtained at this temperature might be converted into viscosity at 100 deg. F. and at least an approximate value obtained that would yield sufficient information until a more accurate determination could be made.

TABLE II. COMPARATIVE RESULTS OF ATRECO AND SAYBOLT VISCOSITY

	Tube 1 Factor 10.3				Tube 5 Factor 9.00			
Oil	Time, Sec.	Atreco Visc.	Saybolt Visc.	Dif.	Time, Sec.	Atreco Visc.	Saybolt Visc.	Dif.
1	8.4	86.5	86.8	0.3	9.6	86.4	86.8	0.4
2	14.1	145.2	145.6	0.4	16.2	145.8	145.6	0.2
3	22.2	228.7	229.0	0.3	25.5	229.5	229.0	0.5
4	46.1	474.8	475.2	0.4	52.7	474.3	475.2	0.9
9*	9.0	92.7	92.7	0	....	.....	.....	...
10*	10.8	111.2	111.3	0.1	....	.....	.....	...
11*	15.0	154.5	155.8	1.3	....	.....	.....	...
12*	17.3	178.2	178.3	0.1	....	.....	.....	...
	Tube 18 Factor 11.64				Tube 19 Factor 12.63			
5	7.9	92.0	92.0	0	7.3	92.2	92.0	0.2
6	12.6	146.7	146.6	0.1	11.6	146.5	146 6	0.1
7	20.1	234 0	234.6	0.6	18.5	233.7	234 6	0.9
8	40.8	474.9	475.2	0.3	37.6	474.9	475 2	0.3

* Compounded specially for test.

Laboratories of the Atlantic Refining Co.,
Philadelphia, Pa.

Resistance Type Electric Furnace Tested for Steel Melting

THE value of the arc furnace of the Heroult type in the production of the highest grades of steel has become so well known that it is now generally accepted that steel of crucible quality can be made without difficulty in these furnaces, and already a large part of the highest quality of steel is so made.

However, it has been found difficult to replace all the crucible pots on account of the difficulty in pouring ingots from a ladle without some sculling. One reason why they are still used for some high-grade steels is the convenience of the small size pots for special mixtures, allowing small heats to be poured; and the fact, as

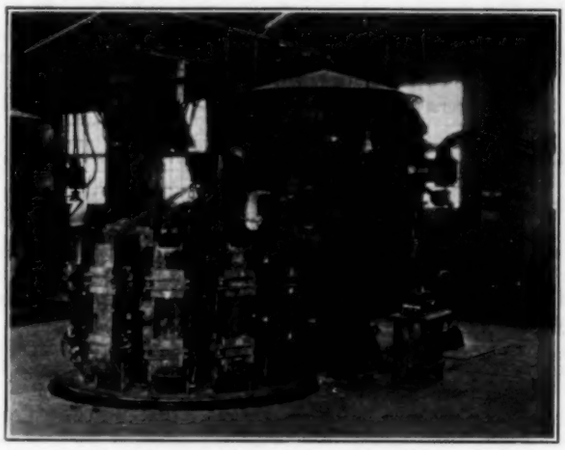


FIG. 1. BAILY FURNACE AND CASTING TABLE USED FOR MELTING STEEL

mentioned above, that the existing type of arc furnace in service requires a ladle in order to pour the charge into the molds, which gives a marked difference in the teeming temperature of the metal between the first ingot poured out of the ladle and the last ingot, as well as the loss of metal in the form of scull in the ladle.

In order to obviate these difficulties in the existing type of electric unit, the Electric Furnace Co. has recently carried out experiments in its laboratory at Salem, using its resistance type furnace, with the view to adapting it for that portion of crucible quality steel now handled in pots. The company's 1-ton furnace is built in the nose-tilting type, alongside a casting table on which molds are mounted (Fig. 1), so that the metal can be poured directly to the molds without any ladle at all, which is the practice where these furnaces are used in brass-rolling mills. This gives uniform temperature throughout the pour, eliminates the ladle entirely and makes the pouring condition analogous to that of crucible practice.

Tests showed that there was no difficulty in keeping steel of as low carbon content as 0.05 per cent at good pouring temperature. The maximum temperature obtained on the hearth was 1,850 deg. C.

The test sheets (Table I) show not only the temperature obtained but the melting rate as well. These tests and subsequent tests indicated that crucible quality steel can be made and poured in small furnaces of this type with a current consumption of not to exceed 1,200 kw.-hr. per ton, which, while much higher than the figures obtained in arc practice, nevertheless will produce steel much more economically than by crucible practice.

TABLE I. STEEL RUN TEST IN A BAILY ELECTRIC FURNACE, SALEM LABORATORY, THE ELECTRIC FURNACE CO.

Date	Time	Amp.	Kw.	Voltage	Bath Temp., Deg. F.	Meter Reading, Kw.-Hr.	Remarks
2/21/21	8 p.m.	1,040	68	60	3,002	200,454	No. 6 Cone down 3,002 F.
	9 p.m.	1,020	67	60	3,030	.....	
	10 p.m.	1,080	70	60	3,050	.....	
	11 p.m.	1,080	70	60	3,080	.....	
	12 p.m.	1,100	70	60	3,110	.....	No. 29 Cone down
2/22/21	1 a.m.	1,140	74	60	3,100	.....	
	2 a.m.	1,180	76	60	3,100	.....	
	3 a.m.	1,140	75	60	3,090	.....	
	4 a.m.	1,180	75	60	3,070	.....	
	5 a.m.	1,160	75	60	3,060	.....	
	6 a.m.	1,080	71	60	3,050	201,185	
	7 a.m.	1,160	75	61	3,060	.....	
	8 a.m.	1,120	73	61	3,080	201,333	
	9 a.m.	1,040	67	60	3,090	201,391	
	9:30 a.m.	1,000	65	61	3,100	201,421	600 lb. boiler plate scrap charged
	10 a.m.	1,260	100	75	3,080	201,462	
	11 a.m.	1,240	90	70	3,070	201,553	
	12 a.m.	1,240	92	69	3,090	201,647	
	1 p.m.	1,380	98	70	3,110	201,733	
	1:30 p.m.	1,400	100	69	3,120	201,792	400 lb. boiler plate scrap charged
	2 p.m.	1,320	95	74	3,120	201,840	
	3 p.m.	1,240	90	70	3,140	201,924	20 lb. limestone charged 4:10
	4 p.m.	980	65	64	3,090	202,009	5 lb. roll scale charged 4:40, poured at 4:52

The furnace used for the steel test was a standard 7-ft. diameter, brass-melting furnace, having a hearth capacity of 2,000 lb.; and in addition to the 4½-in. firebrick lining used in brass melting, a 9-in. magnesite brick lining was placed directly inside. The roof was made of 9-in. silica soap shapes, and was not insulated.

Synopsis of Recent Chemical & Metallurgical Literature

Elastic Properties of Steel After Overstrain.—Research Department Report 45, issued by the Woolwich Arsenal, England, under authorship of R. H. Greaves, is abstracted in the *Iron and Coal Trades Review*, July 15, 1921. Tables I and II give an outline of the main results of the study. Samples 3 and 5 were overstrained in compression, then tested in tension, and it was found that the elastic limit had fallen almost to zero. A marked reduction in the virgin

TABLE I. ANALYSES OF MATERIALS TESTED

Mark	Material	C	Si	Mn	S	P	Ni	Cr
1	1-in. bar	0.34	....	....	....	....	....	....
2	Normalized proof shot	0.50	0.16	0.70	0.048	0.056	....	....
3	2½-in. bar	0.77	0.12	0.34	0.03	0.027	....	....
4	12-in. howitzer jacket*	0.34	0.10	0.64	0.031	0.025	3.65	....
5	Cast 12-in. H.E. shell (heat-treated)	0.32	0.24	0.49	0.031	0.024	2.12	1.45
6	1-in. bar, air-hardened and tempered	0.30	0.16	0.26	0.017	0.028	1.95	5.23

* Tested transversely.

elastic limit in tension occurred even after low-temperature annealing. Cold-drawn gun wire is also known to be more reluctant to recover its original elastic limit than the same normalized steel after less severe overstrain.

It is evident that, in general, recovery of the virgin elastic limit after overstrain in tension proceeds slowly at atmospheric temperature (in some cases very slowly) and more rapidly with increased temperature. A high-temperature softening anneal, of course; must be avoided. Time for recovery varies directly with the degree of overstrain. Rate of recovery also depends upon composition and heat-treatment (being slow for hard steels).

Interpreted in terms of the amorphous theory, the author points out that amorphous material generated at crystalline slip planes is initially in a mobile condition, and on reloading allows the steel to acquire a permanent set at

comparatively low loads—hence the lowered elastic limit. Unloading is accompanied by a return flow of the viscous material, resulting in a greater contraction than corresponds to the elastic contraction of the crystalline material, a backward creep which sometimes continues after all load is removed. These experiments indicate a considerable variation in viscosity of this yielding material. The amorphous material "sets" or becomes rigid in some manner after a certain time, depending on the temperature. It is still thought to be non-crystalline, but in a hard, non-yielding or vitreous condition, and as such prevents further slip on the same gliding planes and stiffens the mass of the metal.

TABLE II. EFFECT OF REPEATED TESTS ON ELASTIC LIMIT

Mark	First Overstrain	Complete Recovery of Elastic Limit	Effect on Young's Modulus	Partial Recovery of Elastic Limit
(1)	1.5 per cent stretch	10 min. at 100 deg. C.	Restored.....	.....
(1)	6.5 per cent stretch	40 min. at 100 deg. C...	Small decrease	.....
(2)	Moderate stretch..	12 hr. at 100 deg. C....	Restored.....	32 mos. at atmosphere
(2)	Further and repeated stretches..	1 hr. at 195 deg. C.....	Restored.....	.....
(4)	2 per cent stretch...	1 hr. at 200 deg. C.....	.....	33 mos. at atmosphere
(5)	Moderate stretch..	31 mos. at atmosphere. 2 hr. at 100 deg. C..... 1 hr. at 195 deg. C.....	See note 1.....	.....
(6)	Moderate stretch..	See note 2.....	Restored.....	1 hr. at 350 deg. C.

NOTE 1.—Modulus, originally low, was raised after recovery from overstrain. Successive loadings caused progressive approach to the proportional line up to the load applied, the successive permanent sets tending toward zero. The proportionality reached by loading and unloading in this way was quite fictitious, as an indication of the elasticity of the material, and corresponded to a much reduced modulus.

NOTE 2.—Proportional limit very difficult to determine, but recovery not complete after 1 hr. at 350 deg. C.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process of Producing Formaldehyde.—The commercial production of formaldehyde from methanol by catalytic oxidation requires relatively pure raw materials and temperatures of 400 deg. C. or higher. It has been found that by using vanadium pentoxide as the catalyst it is possible to produce better yields of formaldehyde from the methanol, that the catalyst is not affected by poisons such as acetone and water, which are the common impurities of methanol, that it reacts at a sufficiently low temperature to be below the decomposition point of formaldehyde and that a large excess of air is beneficial to the reaction. A temperature as low as 225 deg. C. can be used and it is claimed that methanol containing as much as 5 per cent of acetone will give satisfactory yields. (1,383,059; George C. Bailey and Augustus E. Craver, assignors to The Barrett Co. of New Jersey; June 28, 1921.)

Manufacture of Acetaldehyde.—Howard W. Matheson, of Shawinigan Falls, Que., Canada, has patented an improved process for producing acetaldehyde on a continuous, commercial scale and without the formation of resins and condensation products of the aldehyde. It is also claimed that with the new process there is a saving in the amount of catalyst required. The process consists of passing commercial acetylene through dilute sulphuric acid, containing not more than 6 per cent of acid and a small amount of a mercury salt. The gas is passed through in greater excess than is required to form the acetaldehyde. The reaction is carried out at comparatively low temperature and pressure, thus avoiding the danger and corrosive action common to the older process. The mercury salt is very slowly reduced and does not remain in suspension in the liquid, but settles to the bottom of the reaction vessel, where it can be easily drawn off. The large excess of acetylene carries the aldehyde out of the reaction liquid as soon as it is formed, so that it does not remain in contact with the acid a sufficient length of time, nor is it subjected to a sufficiently high temperature to form aldehyde resin or crotonaldehyde or other undesirable products. The yield of aldehyde is large, equaling almost the theoretical amount, and is produced very rapidly. (1,384,842; July 19, 1921.)

Acid-Resisting Alloy.—Colin G. Fink, of Yonkers, N. Y., assignor to Chile Exploration Co., of New York, has been granted a patent for an alloy to be used for withstanding the corrosive action of mixtures of sulphuric, nitric and hydrochloric acids such as are sometimes encountered in the acid liquors in the electrodeposition of copper. The alloy he describes contains lead, tin and thallium. The lead may, if desired, contain some hardening agent such as barium, which may be present in amounts up to 3 per cent. A typical example of this type of alloy had the following composition: lead, 70 per cent; tin, 20 per cent, and thallium, 10 per cent. The thallium content may be varied, however, from 3 to 65 per cent and as much as 25 per cent of tin may be used. (1,384,056; July 12, 1921.)

Halogenating Hydrocarbons.—If toluene or its homologues are chlorinated or brominated in the vapor stage, at the temperature of the boiling hydrocarbon, it is necessary that the reaction be carried out in strong light and in the presence of a catalyst such as sulphur or phosphorus. Furthermore there is often a loss of the hydrocarbon carried away in the acid gas evolved, and this gas is extremely corrosive to equipment. There is also a loss caused by the formation of nuclear halogenated products. In a recently patented process the halogen is introduced into the hydrocarbon while the latter holds in suspension an alkali-metal carbonate. It is claimed that the reaction is more rapid than could otherwise be effected at low temperatures and in the absence of light and in the presence of iron or other substances which act as catalysts for the nuclear halogenation. The corrosive action is minimized. The process is particularly applicable for producing such compounds as benzyl chloride, benzal chloride and benzotrichloride, with the production of but relatively small amounts of nuclear chlorinated products such as chlortoluene. (1,384,909; Chauncy C. Loomis, assignor to Semet-Solvay Co., of Solvay, N. Y.; July 19, 1921.)

Production of Anhydrous Antimony Trichloride.—A continuous process of making antimony trichloride, which has recently been patented by Oliver C. Ralston, of Niagara Falls, N. Y., consists of passing chlorine gas through crushed antimony metal submerged beneath a bath of molten anhydrous antimony trichloride. The chlorine is supplied at a rate sufficient to maintain the bath in a molten state due to the exothermic reaction between the antimony and the chlorine. The trichloride is withdrawn from the reaction chamber in either liquid or vapor phase and subjected to subsequent distillation for refining purposes. Because of the constant presence of an excess of antimony metal, a product free from the objectionable antimony pentachloride is obtained. (1,384,918; assigned to Hooker Electrochemical Co., of New York, N. Y.; July 19, 1921.)

Canadian Patent

Leading-in Wire or Platinum Substitute.—This wire is composed of a core of a low expansion metal or alloy and an outer sheath or sleeve of copper whose coefficient of expansion is decidedly above that of glass. The resultant expansion coefficient of this compound wire is substantially the same as that of glass. One advantage of using copper as the sheath metal, besides its high electrical conductivity, is the great affinity of the copper oxide for glass in a semi-molten condition. That is to say, the copper will cement itself to the glass "hermetically" at the ordinary temperatures used in sealing-in operation. The wire is suitable for incandescent lamps, mercury arc rectifiers, etc. (Can. Pat. 212,365. Colin G. Fink, assignor to Canadian General Electric Co., Ltd., Toronto. July 5, 1921, *Cf.* British Pat. 23,775, 1912.)

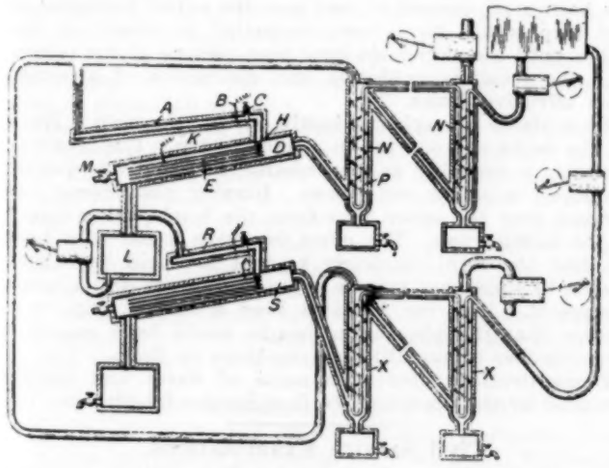
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Pickling Metals.—A bath for removing scale from iron or steel articles contains ferrous sulphate and sulphuric acid. To accelerate the action, hydrochloric or nitric acid, or both, may be introduced. As an example, the solution contains 38 lb. of ferrous sulphate dissolved in 300 gal. of water and 112 lb. of sulphuric acid (sp.gr. 1.84). In addition, 16 lb. of nitric acid or 20 lb. of hydrochloric acid with 12 lb. of nitric acid may be added to the solution. (Br. Pat. 163,868. Rustproofing Syndicate, Ltd., Westminster, and T. F. Newman, London; July 20, 1921.)

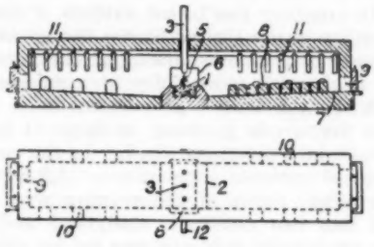
Glycerine.—Glycerine is produced by fermenting sugar solutions containing a mixture of about equal weights of alkali bisulphite and sulphite. The mixed sulphites may be added in successive small quantities to a proportion corresponding to the percentage of glycerine desired, the proportion of acetaldehyde and alcohol being greater the less the proportion of sulphites; and the liquid may be maintained approximately neutral by successive additions of alkali bisulphite solution or by increasing the proportion of bisulphite in the additions of the mixed sulphites. In an example in which the maximum glycerine yield was required, 311 gal. of a solution of crude cane sugar equivalent to 788 lb. glucose was fermented by 40 lb. of yeast at a temperature of 25-37 deg. C. for nine days, and during the first five days 176 gal. of mixed sodium sulphite and bisulphite solution equivalent to 545 lb. Na_2SO_3 was added in doses first of 40 lb. and then of 30 lb. mixed salts in 16 gal. of water. In this way, 336 lb. glycerine, 172.2 lb. acetaldehyde, and 37.4 lb. alcohol were produced. (Br. Pat. 164,034. A. T. Cocking, Sutton, Coldfield, and C. H. Lilly, Birmingham; July 20, 1921.)

Distilling Petroleum Oils, Distillates and Tars.—In distilling petroleum oils, distillates and tars, the oil is forced by a pump through preheating tubes *P* in the condensers *N* and through a tube *A* heated by an electric coil and is admitted through a valve *C* into an evaporator *D* heated by a surrounding electric coil or by other means. The liquid is distributed by funnels *H* on to a series of inclined plates *E*.



The vapors are withdrawn by a pump, which maintains a reduced pressure in the evaporator, through a series of condensers *N* maintained at different temperatures by the pipes *P* through which the oil supply flows in series. The residual liquid from the evaporator *D* passes to a vessel *L* from which it is forced through a similar heater *R* and evaporator *S*, in which it is treated with air to yield asphalt. Vapors evolved in the evaporator *S* are withdrawn through a series of condensers *X* cooled by passage of crude oil through tubes contained within them. Steam may be admitted to the evaporator through a valve *M*. Temperature-regulators *P*, *K* are fitted to the heater *A* and evaporator *D*. In a modified apparatus, the heaters and evaporators are heated by gas or oil fuel burners, the residue from the first evaporator is passed through the cooling coils of the condensers connected to the asphalt chamber, and is passed through an intermediate heater and evaporator before being treated to form asphalt. Cracking of the oils may be obtained by heating them above 400 deg. C. (Br. Pat. 163,363. V. C. Illing and J. Kelly, both of London; July 13, 1921.)

Electric Furnace.—A furnace of the type is which heating is effected by the combined use of arcs and resistances is provided with a floor on one or both sides of the heating zone on which a number of objects may be placed for preheating or other purposes. The arcs 5 extend between a number of vertical electrodes 3 and a bed 1 of granulated coke, graphite or the like in a trough 2 of refractory materials provided with a contact member 12. The electrodes may be arranged for direct, single-phase, two-phase or



three-phase current. Blocks 6 of carborundum or the like protect the walls of the furnace at the ends of the bed 1. A slightly inclined floor 7 extends on each side of the bed and is adapted to receive articles to be heated such as ingots 8 through door openings 9. Other openings 10 in the side walls permit the articles treated being moved relatively to the heating zone. Coils, strips or rods 11 are provided laterally of the heating zone to preheat the articles in the furnace. A trough or hearth with a taphole is provided close to the heating zone. The heat may be controlled by lengthening the arcs, disconnecting one or more electrodes or varying the voltage which is applied. (Br. Pat. 164,019; not yet accepted. I. Rennerfelt, Djursholm, Sweden; July 20, 1921.)

Reduction of Iron Ores.—Iron ore in finely grained condition is heated directly up to 1,100 deg. C. or higher—for example in a rotary kiln—and then transferred to a reduction furnace indirectly heated. Fluxes may be added before preheating or may be separately heated and mixed in the reduction furnace, to which is also added carbon or coal as is required for complete reduction of the ore. The temperature is maintained above 1,000 deg. C. but below the melting point of iron. The solid, sintered mass of iron formed is discharged, without admission of air, into another furnace, where it is melted and slag removed; the iron may be further purified and carbonized in another smelting furnace A part of the gases liberated in the reduction furnace and consisting of carbon monoxide (and hydrogen and hydrocarbons if the fuel is coal) is burned in the heating channels of the reduction furnace, a second part is used for heating the smelting furnace, and a third part may be used for preheating the ore and fluxes by direct contact with the combustion products. (Br. Pat. 163,561. S. J. Vermaes, Delft, and Syndicaat "Electro-Staal." (The Hague, Holland; July 13, 1921.)

Removal of Dissolved Oxygen From Water.—In the removal of dissolved oxygen from water by filtration through iron filings or turnings, the layer of rust on the latter which retards complete oxidation of the filtering medium is reduced by allowing the iron and the rust to react upon each other to give ferrous hydrate. When no longer capable of rapidly absorbing oxygen, a portion of the filter bed is kept full of water until the medium becomes active again. The ferric oxide finally produced is removed from the filter by means of a current of water or steam or by stirring by mechanical means. Iron or steel filings or turnings containing from 0.5 to 6 per cent of manganese are used as the filtering medium. The manganese, acting as a catalyst, hastens the fixation of the oxygen. (Br. Pat. 164,711 and 164,712; not yet accepted. P. Kestner, Boulogne, France; Aug. 4, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Chicago Section, A.C.S., Holds First Fall Meeting

The Chicago Section of the American Chemical Society held its first monthly meeting of the winter season at the City Club on Sept. 23. The paper of the evening was presented by Charles H. MacDowell, president of the Armour Fertilizer Works, and dealt with science and the coming agriculture. In treating the broad subject of conservation of national fertility in the United States the speaker showed the definite research problems ahead of the chemist. The paper will be dealt with more fully in a subsequent issue of CHEMICAL & METALLURGICAL ENGINEERING.

The Chicago Section is growing so large it has become necessary to split into divisions similar to the organization of the semi-annual national conventions. After the discussion on the principal paper of the evening was closed, the members split into two divisions, analytical and synthetic. The discussion on definite subjects was led by able speakers in each division and many members participated. Arrangements have been made for four divisional meetings at the next monthly assembly.

American Gas Association to Meet in Chicago

Although the final program of the American Gas Association's annual convention in Chicago, Nov. 7 to 12, has not been completed, the following papers are announced:

"Why Should Gas Companies Sell Their Tar to Distillers Instead of Working It Themselves?" R. P. Perry.

"Report of Committee on Disposal of Waste From Gas Plants," F. W. Sperr, Jr.

"Report of Purification Committee," A. C. Fieldner.

"Selected and Annotated Bibliography on Gas Purification," A. R. Powell and K. C. Walker.

"The Seaboard Liquid Process of Gas Purification," F. W. Sperr, Jr.

"Effect of Moisture on Activity and Capacity of Oxides for Gas Purification," W. A. Dunkley.

"What Goes On in a Water Gas Machine?" M. E. Benesh.

"Some Experiments With the Mixing of Different Gravity Gases in Holders," H. E. Bates.

"Utilization of Compressed Air in Clearing Gas Piping," J. T. Griffin.

New Oil Companies

During the month of August, new oil companies were organized with an aggregate capitalization of $141,544,000, including all concerns with an indicated capital of $50,000 or over. For the first time in the present year the total exceeds that of the corresponding month of a year ago; in August, 1920, the indicated investment of new companies was $118,370,000. An aggregate of 72 companies was formed in the 1921 August period, as against a total of 69 in July, and 103 in August, 1920. For the first eight months of the present year the showing represents 686 new companies organized in this line, with a total capitalization of $992,601,600; in the same period of 1920, 2,136 new companies were formed with an aggregate indicated capital of $1,777,876,000.

Sweden Lifts Export Embargo on Fertilizers

The Swedish Government announces that beginning Oct. 1 the export embargo on raw phosphate and other fertilizers was lifted.

Explosion in German Saltpeter Works

An explosion occurred Sept. 23 in the saltpeter works at Kleinlaufenberg, near Karlsruhe, Germany. Several men were killed and the material damage was considerable.

Lehigh Chemical Society Meets

The first meeting of the 1921-22 season of the Lehigh Valley Section of the American Chemical Society was held in the lecture room of the chemical laboratory, Lehigh University, Bethlehem, Pa., on Wednesday evening, Sept. 28. The meeting was preceded by a dinner at 6:30 at the Bethlehem Club.

The evening was given over to a program devoted to a "Symposium on Engineering Education," with nine or ten speakers dealing with different phases of the subject, each followed by a short general discussion. Each speaker devoted about 5 minutes to his topic. The program was:

General talk, Dr. Edward Hart; "Education for Research," Dr. H. M. Ullman; "Preparatory Education," Prof. A. A. Diefenderfer; "Resume of Educational Talks, New York Meeting," Dr. E. C. Bingham; "Culture Studies for the Engineer," Prof. A. C. S. Fasig; "The College Man and Business," J. T. Baker; "The Self-Made Man," Dr. Joseph W. Richards; "Relation of the College to Industry," Prof. D. S. Chamberlain; "Preparation for Leadership," F. G. Breyer.

Gas Used Successfully Against Old Alabama

The Chemical Warfare Service is more than pleased with the showing made with gas and phosphorus bombs dropped from airplanes on the old battleship Alabama. Even without the ventilation system being in operation, it was shown that the tear gas from the bombs dropped on the ship had penetrated throughout the vessel. As a matter of fact, the whole vicinity was so heavy with tear gas that it was four hours before the boat could be boarded without masks. Even as it was, members of the observing party had frequent use for their handkerchiefs for many hours afterward. The experiment demonstrated clearly that had poison gas been used, instead of tear gas, the entire personnel of any ship would have been compelled to resort to gas masks until the ship could have been cleared of the poison, with the resulting confusion and distraction of attention from offensive duties.

Four 100-lb. phosphorus bombs struck the ship. Three hit the decks and one fell in a fighting top. The resulting spectacle is described as stupendous. The ship was quickly enveloped in smoke and flames. Burning phosphorus was sprayed over the entire ship from the bomb which lodged in the fighting top. The effect in action would have been to blind the ship completely so that it would have been unable to single out targets or to operate its anti-aircraft equipment. Had the Alabama been a hostile ship, it is certain that the phosphorus bombs would have caused a large number of casualties among those on deck.

Demonstrations also were made of flares and signals prepared by the Chemical Warfare Service for airplane use.

Civil Service Examinations

The United States Civil Service Commission announces competitive examinations for the positions noted below on Nov. 2, 1921. Vacancies at the United States Naval Academy, Annapolis, Md., at $4.80 to $5.04 per diem, and in positions requiring similar qualifications will be filled from these examinations.

Chemical Laboratorian (Analytical).—The duties of the appointee will be to assist in the physical and chemical laboratories, prepare solutions, set up chemical and physical apparatus, make repairs, and conduct experimental work.

Chemical Laboratorian (Metallurgical).—The duties of the appointee will include physical tests, heat treatment, and metallographic examination of metals; determination of transformation temperatures; calibration of instruments, such as pyrometers; calculation and plotting of results of tests; making sketches and drawings of apparatus.

Rubber Mills at Trenton Operating at Capacity

The different rubber mills at Trenton, N. J., have now practically all resumed operations, including those devoted to the manufacture of automobile tires and tubes and mechanical rubber goods. A survey of the plants shows the following situation:

The Bergougnan Rubber Corp., Whitehead Road, with plant devoted to tire and tube production, is giving employment to about 250 operatives, with schedule including night shift. It is expected to add additional employees to the working force at an early date.

The Ajax Rubber Co., Breunig Ave., is maintaining capacity manufacture for automobile tires and tubes. The plant is running under a 24-hour schedule, six days a week, with current production totaling about 6,000 tires in this time.

The Hamilton Rubber Manufacturing Co., Mead and Prince Sts., manufacturer of mechanical rubber goods and automobile tires, is operating on a basis of from 60 to 75 per cent of maximum capacity.

The Thermoid Rubber Co., Whitehead Road, manufacturer of automobile tires and mechanical rubber goods, is running on a basis of about 70 per cent of normal, with the bulk of production devoted to tires. It is said that other departments of the plant are showing improved conditions, including those devoted to the manufacture of belting, brake lining and hose.

The Empire Tire Co,. Mulberry and North Clinton Sts., is operating at a capacity of from 60 to 75 per cent of normal.

Improved Conditions in the Glass Industry

The general improvement in conditions in the glass-manufacturing industry during the past few weeks is leading to the resumption of operations by different plants in this line in all parts of the glass-making sections of the country. Recent plant openings are:

The Jeanette Glass Co., Jeanette, Pa., has started up with two tanks in operation, to develop a capacity of about 90 per cent of normal. Approximately 900 employees have been taken on.

The Central Glass Co., Wheeling, W. Va., has resumed partial production, following a suspension of operations since July 1. About 150 men will be employed at present, and this number is expected to be increased soon.

The Bridgeport Lamp Chimney Co., Bridgeport, near Clarksburg, W. Va., has reopened its plant, giving employment to about 150 men.

After a shut-down of several months, the Gill Brothers Co., Steubenville, Ohio, has resumed manufacture at its local Acme plant, with one furnace in operation. It is planned to increase the rate of output in the near future.

The Bellaire Bottle Co., Bellaire, Ohio, has reopened its plant on a basis of three days a week until further notice.

The Standard Glass Works, Marion, Ind., has resumed operations at its local plant, following a shut-down of several weeks. The Canton Glass Co., in this same city, is also operating its plant under good capacity, and reports a marked increase in orders.

Waste Alundum Subject to Duty

The Board of United States General Appraisers, New York, has overruled a protest of the Norton Co., Worcester, Mass., relative to the assessment of duty on waste alundum. The alundum, consisting of grains or shavings produced in the process of truing grinding wheels made of the same material (crude artificial abrasive) was classified as waste at 10 per cent ad valorem, under paragraph 384 of the tariff act of 1913. The Norton Co. claimed that the material was entitled to free entry as a crude artificial abrasive under paragraph 479. The evidence submitted. in the judgment of the board, failed to sustain the protest.

German Plants Close Down

During the past week the dye works at Höchst-am-Main and the Chemischefabrik at Griesheim have been closed down owing to labor disputes, the owners refusing to grant increases in wages demanded by the workers, according to a Reuter cable from Berlin.

Holyoke Paper Mills Show Increased Business

The general business situation in the Holyoke section is showing a marked improvement at the present time. The textile mills are all working on a schedule at least approximating full time, while one or two concerns are running two shifts.

The improvement in paper manufacturing, while not so marked, has been notable since Sept. 1. Part of this may be only temporary because of large orders for papeteries for the holiday trade, but there is reason to believe that a slow but steady increase of business in all lines is under way.

The paper business is in good shape for a resumption of activities all along the line, for paper stocks in the hands of merchants are low and consequently the new prices made by the manufacturer are quickly passed on to the consumer, while a stiffening in the price of certain grades of rags caused by the rise of cotton prices leads to the belief that this important raw material has reached its lowest level. The pulp manufacturers have to a large extent worked off their inventories. As this pulp was made from wood cut at the highest level of war prices and worked up into pulp at higher prices than have been reached before or since, they had to take losses during readjustment.

Considering freight rates, it is safe to say that pulp is nearly as low as it has ever been and any further reductions can be brought about only by forced liquidation of remaining stocks or by lowering of freight charges. Some foreign pulp is being offered for sale, but a large part of this is of inferior quality.

As in other sections, nearly all manufacturers curtailed or eliminated their research work—not because they regarded it as a luxury but because every avenue of expense must be cut off until some signs of light appeared. Research work will be continued when finances permit.

Freight Movement Increases

During the week which ended Sept. 17, 853,762 cars were loaded with revenue freight on the railroads of the United States, according to reports just received from the carriers by the Car Service Division of the American Railway Association. This is the largest number loaded during any one week, records show, since the week of Dec. 4, 1920.

The total for the week was 105,644 cars greater than that for the previous week, when, however, the observance of Labor Day resulted in a falling off in traffic. It was, however, 137,404 cars less than were loaded during the corresponding period last year and 141,229 less than during the corresponding period in 1919.

Increases in the loading of all commodities over the week before were reported but in making comparisons, consideration must be given to the fact that the week of Sept. 17 contained six full working days, while there was a holiday during the preceding week. Grain and grain products was the only commodity which showed an increase over the corresponding week last year.

Agricultural Chemists to Meet

No less than 250 agricultural chemists are expected to be in attendance at the thirty-eighth anuual convention of the Association of Official Agricultural Chemists which will be held in Washington Oct. 24 to Oct. 26. The drug section of the association is to have the center of the stage at this meeting. At the last annual meeting principal attention was concentrated on fertilizers. Those in charge of arrangements make it clear, however, that fertilizers and other sections are in no way to be neglected.

The principal addresses are to be those of Secretary of Agriculture Wallace, Harvey W. Wiley and Senator E. F. Ladd. Both Dr. Wiley and Senator Ladd are past presidents of the association. Dr. Wiley had not expected to be present at this convention, due to the fact that he expected to submit to an operation for cataract of the eye prior to the date of the meeting. The time for the operation has been postponed, however, until November, which will permit of Dr. Wiley's personal attendance at the convention. Neither Secretary Wallace nor Dr. Wiley has announced his subject as yet, but Senator Ladd will speak on "The Agricultural Chemist and His Influence on Agriculture."

Forecast of Beet Sugar Crop

From late reports, covering practically all factories, the United States Sugar Manufacturers' Association has compiled the following detailed forecast of the forthcoming beet sugar crop:

State	Area Planted, Acres	Area Estimated to Be Harvested, Acres	Estimated Tonnage of Beets, Short Tons	Estimated Production of Sugar, Short Tons
California	132,232	119,962	1,092,478	173,361
Colorado	214,040	201,307	2,280,763	290,400
Utah	112,371	99,965	1,434,195	174,535
Idaho	49,096	47,174	475,670	61,825
Michigan	158,569	143,563	1,118,360	141,241
Ohio	40,213	3,848	322,930	45,747
Wisconsin	19,900	18,000	177,000	19,250
Wyoming and Montana	29,400	28,000	264,000	35,100
Other States*	124,905	119,820	1,077,000	135,900
Total U. S. 1921–22	880,326	812,612	8,242,396	1,077,359
1920–21	978,500	872,376	8,546,193	1,090,021

* Includes Nebraska, Kansas, Iowa, Indiana, Illinois, Minnesota and Nevada.

The following factories will not operate during the forthcoming campaign: Hamilton City, New Delhi, Chino and Tracy, Cal.; Las Animas, Lamar and Delta, Col.; Filer, Utah; Waverly and Belmond, Iowa.

The factory located at Fallon, Nev., which has been idle for several years, has been purchased by the Lahonton Valley Sugar Co., of Bay City, Mich., and will be operated during the campaign.

On account of litigation the Hooper, Utah, and Preston, Idaho, factories may not operate, although these factories have considerable acreage planted.

In California the campaign is in full swing, the Spreckels factory being the last to start slicing, on the 17th of September. The crop is reported to be from fair to good.

In the Utah-Idaho district the campaign will not be well under way until the first week in October. The condition of the crop in this section is reported to be exceptionally good, with prospects for a large tonnage.

The crop condition in Michigan is reported as fair to good, while in Ohio it is only fair. With the exception of the Toledo factory slicing will not begin until after the first week of October. Several of the plants do not expect to start until after Oct. 15.

Reports from Colorado indicate an exceptionally good yield this year, both as to tonnage and sugar content. It is expected that by the end of this week most of the factories will be in operation.

To Investigate White Clays and Bauxites of Central Georgia

The Ceramic Experiment Station of the U. S. Bureau of Mines located at Columbus, Ohio, has entered into a cooperative agreement with the Central of Georgia R.R. through its industrial agent, J. M. Mallory, and its president, William A. Winburn, whereby the Ceramic Station is to investigate the white clays and bauxites along the right of way of the railroad, the lines of which pass through about 80 per cent of the white clay and bauxite belt of Georgia. The white clay deposits of Georgia are so numerous and extensive that it can be said that this material is practically inexhaustible. A number of deposits are from 20 to 40 ft. in thickness and cover in many instances as much as 200 acres in extent.

Bauxite beds occur especially in the Cuthbert, Republic and Andersonville districts from 4 to 8 ft. in thickness, and deposits are found which vary in composition all the way from kaolin on the one hand to bauxite on the other. According to the geology of these deposits, which occur on the coastal plain, the bauxites are derived from the alteration of kaolin, which was derived from the decomposition of pragmatite and granitic rocks of the Piedmont plateau to the north of the coastal plain. The kaolin was transported by water from the site of its formation and deposited at the lower level, where it was built up in many instances as much as 25 to 30 and even 40 ft. in thickness. The close association between the kaolins and bauxites indicate that the latter was derived from the former by the action of sulphuric acid produced by the dissociation of large beds of pyrites.

The white clays are being mined at a few points, more especially at Gordon, McIntyre, Claymont and Butler, and sold principally to the fillers trade. Bauxites have been mined in the Cuthbert, Toomsboro and Andersonville districts and find uses principally for the manufacture of alum, aluminum and abrasives. For strictly ceramic purposes very little is known of the physical properties of these materials, known as Georgia kaolin, bauxitic clays and bauxites.

The work, which is to be done under supervision of R. T. Stull, chief ceramist of mines, consists in devising better refining methods and the testing of the physical properties of the materials so prepared. For this purpose twenty-four representative samples of two tons each have been gathered by the Central of Georgia R.R.'s representative, Dr. T. Poole Maynard, and delivered to the Ceramic Station. A small-size washing plant is being constructed at the Ceramic Station capable of handling about 1,000 lb. to a charge. The working properties, drying and burning behaviors, burning color and refractoriness of the different separations in the washing process are to be determined. Chemical analyses of these samples are also to be made, since the analyses are important more especially with respect to the highly aluminous clays and bauxites.

New Directory of Canadian Chemical Industries

The Directory of Chemical Industries in Canada, published by the Dominion Bureau of Statistics, has been revised as of Jan. 1, 1921.

In the present edition there are shown the names of more than 800 firms operating over 1,000 plants in Canada. Geographically, plants operated by these firms fall into the following divisons:

Nova Scotia	61	Manitoba	51
Prince Edward Island	8	Saskatchewan	7
New Brunswick	35	Alberta	39
Quebec	279	British Columbia	91
Ontario	431	Total	1,002

For convenience of reference, as in the first edition, all the products listed under the different firms have been cross-indexed, so that all the concerns known to be making any one article are found under that heading.

The introductory material includes an article on "Canadian Chemical Industries in the Reconstruction Period—Opportunities for Chemical Progress," by S. J. Cook, chief of the mining, metallurgical and chemical branch, and tables of Canadian imports and exports of chemical and allied products during the fiscal years ended March 31, 1914, 1918 to 1921.

Cause of Disaster at Oppau

It has been ascertaineed definitely, says a Reuter cable from Berlin, that the disaster at the Badische plant in Oppau, Germany, was caused by the explosion of 4,500 tons of a compound of ammonium sulphate and ammonium nitrate, known as ammonsulphatsaltpeter, which has hitherto been considered as being absolutely free from danger of explosion.

Wholesale Prices Go Lower

Wholesale prices of chemicals and drugs were a trifle lower in August than they were in July, according to statistics gathered by the Department of Labor. The department's index number for August is 161, as compared with 163 in July and 216 in August, 1920. The average price in 1913 equals 100.

Carbon Black Ruling

Carbon black, when produced directly from coal-tar derivatives, such as naphthalene or creosote, comes under the provisions of the dye and chemical control act, according to a Treasury Department ruling.

To Do Research Work on Glass

The Glass Containers' Association has agreed to station a research man at the Bureau of Standards to do work on the fundamental physical chemistry of glasses.

Personal

Dr. J. T. BARKER has returned to his headquarters at Widness, Lancashire, England, after two months' special work at the North American Chemical Co., Bay City, Mich.

C. W. BOTKIN, who has been doing research on the refining of shale oils at the Colorado School of Mines for the past fifteen months, has accepted a position as head of the chemistry department in the New Mexico College of Agriculture and Mechanic Arts, State College, New Mexico.

M. J. CAVALIER, professor of metallurgy in the University of Toulouse, arrived Oct. 1 at Columbia University, where he will take up his work as French exchange professor. Prof. Cavalier will stay until Oct. 30.

JOHN JOSEPH GORRELL, who was formerly connected with the technical direction bureau of the Aluminum Co. of America, at New Kensington, Pa., is now chemist with the Cambria Steel Co. in its laboratory.

THOMAS J. KEENAN has announced his resignation as secretary-treasurer of the Technical Association of the Pulp and Paper Industry to accept the position of editor of *Paper*, in the organization of which he becomes an officer and stockholder.

Dr. J. W. KIMBALL, formerly research chemist with E. I. du Pont de Nemours & Co., has become associated with the National Aniline & Chemical Co. in a similar capacity.

J. GEORGE LEHMAN, Bethlehem Foundry & Machine Co., Bethlehem, Pa., has been appointed chairman of the organization committee of the Association of Chemical Plant Equipment Manufacturers, recently formed.

JOHN C. LEONARD, for a number of years secretary and treasurer of the Johnston Window Glass Co., Hartford City, Ind., has resigned.

Dr. W. LEE LEWIS, professor of chemistry, Northwestern University, Chicago, is lecturing through the Middle Western States in a campaign of public education on the American dye industry and what the proposed tariff means.

ROBERT S. LUNT has been appointed manager of the Boston, Mass., office of E. I. du Pont de Nemours & Co.

Dr. JAMES W. MCBAIN, one of the group of noted English chemists attending the recent annual meeting of the American Chemical Society, gave an interesting address before the members of the Delaware Chapter of the American Chemical Society, at Wilmington, Del., Sept. 20. He spoke upon the subject of the characteristics of sols, gels and curds.

W. H. RANSOM, for the past two years an executive officer at the Old Hickory powder works of the Government, has become connected with the Celluloid Co., Newark, N. J.

JOHN I. TIERNEY, Washington representative of the Manufacturing Chemists' Associaton, attended the conference of the state manufacturing associations in Chicago, Sept. 29 and 30, at which the plan for American valuation of imports was discussed.

Obituary

SAMUEL STOCKTON VOORHEES, an engineer chemist who had been a member of the U. S. Bureau of Standards staff for the past eleven years, died at Portland, Me., Sept. 23. Mr. Voorhees had gone to Maine in an effort to better his health, which had been bad for several years. He was fifty-four years of age. Mr. Voorhees received his technical education at Lehigh University and at George Washington University. Prior to joining the Bureau of Standards in 1901, Mr. Voorhees served as a chemist in the research departments of the Pennsylvania, the Southern and the New York Central railroads. Funeral services were held in Cincinnati, Sept. 27.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 3, 1921.

Business in the heavy chemical market continued to improve during the week and buyers are showing more interest, although they are not inclined to buy much more than their needs. Prices showed a decided tendency to firmness and conditions in the trade are much better than at the beginning of last month. Several of those close to the pulse of trading believe that the last quarter will prove to be the brightest of the year and that the improvement in business will be gradual until after New Year's, when it will be brought to its former normal state. Pressure from foreign sources of supply is lighter on account of labor troubles abroad. Germany especially has been handicapped by labor disputes and by the damage suffered by plants in the Oppau district on account of the explosion there. The situation from the American's point of view, therefore, looks much clearer and has every indication of continued improvement.

Soapmakers are leading domestic consumers in the purchase of chemicals. Many of their requirements have been filled with imported chemicals and among these caustic potash has stood foremost. Paper mills have bought quantities of bleach of domestic origin, but have also taken a great deal of domestic material. Textile mills are buying a variety of chemicals, while glass factories are in the market quite frequently for dense soda ash. Conditions among tanneries seem to be greatly improving and it is believed that some good buying will develop in the very near future. Rumors are current that a short interest has accumulated during the past few weeks in soda ash, and these had a tendency to advance prices. Chemical concerns operating in the basic chemical have bought quite freely, believing that the imports from abroad would make it a good gamble. Labor strikes in England and other countries have restricted the importation of ash, while there are great uncertainties of duty and of shipment. There has been very little heard of imported soda ash during the past few weeks. A stiffening market in cyanide of soda, prussiate of soda and soda ash has been the principal factor in the week's activities. There has been a marked shortage of supplies on the two latter items, especially from importers. Caustic potash has held its recent strength and holders are maintaining firm prices. There have been reductions made by manufacturers of sulphuric and nitric acids. These reductions have not had any serious effect on the market, as sales have been made in the past few weeks at these new figures. Bichromate of potash and oxalic acid are somewhat lower. Small-lot sales of the latter have been quite liberal during the past week.

CHEMICALS

Prices on *carbonate of potash* are easier for the various grades, and the market at the close of the week showed declines. Natural offered for shipment was more plentiful, especially for the 80-85 per cent, and the white calcined was offered around 3c. per lb. There has been a reduction on 66 deg. *sulphuric acid* by makers. Quotations now range from $17 to $18 per ton on the 66 deg. acid in tank cars, f.o.b. works. The 60 deg. acid is held at recent levels of $11@$12 per ton. There has been a freer movement noted of late for this chemical at the new prices. Solid *caustic soda* is becoming more firmly established at 4c. per lb. There has been some keen competition among holders of standard goods resulting in the sales of carload lots at slightly lower figures. The offerings of standard brands around the trade are not very heavy and the condition of the market may be described as decidedly fair. Spot *nitrite of soda* was held at 7c. per lb. in most quarters, with transactions noted here and there at slightly lower figures. There has not been very much activity in this chemical and trading is confined chiefly to small quantities. Prices of *ammonium sulphate* are very firm at recent levels. Material in bulk

form at the works is quoted around $2.15 per 100 lb. Supplies for domestic use are exceedingly scarce and consumers find difficulty locating sufficient supplies. Goods in double bags f.a.s. are held at $2.50 per 100 lb. *White arsenic* is lower at 5½@6c. per lb. Imported material has had a bad effect on the spot market prices and trading has been of a light routine nature. Higher prices are recorded for spot *prussiate of soda* and it is very doubtful if better than 13c. per lb. could be done on round lot quantities, while sellers in other directions are asking up to 13¼ per lb. Some odd-lot sales went through earlier in the week at 12¾c. a lb. The condition of this market continues quite firm, with inquiries and orders greatly increased. Prices on *soda ash* are holding at the recent advance and the market closed in a firm position. It is understood that sales of large quantities of imported material have been made which have not been delivered. Some large dealers have found themselves confronted with the problem of covering their orders on a rising market. Domestic spot goods in single bags are quoted at $2.19@$2.25 per 100 lb., depending on the seller and quantity. Goods in barrels held at $2.50@$2.60 per 100 lb. The *cyanide of soda* market is in a very firm condition and second-hand stocks seemed to be well cleared from the market. The 128 per cent was very firm at 24@25c. per lb., while domestic producers are holding their former quotations of 28@30c. per lb. for the 96-98 per cent. *Zinc chloride* producers are still clinging to their old quotations of 9½@12c. per lb. for the fused and granulated varieties, but are practically out of the market in the face of extremely low prices prevailing for imported material. Large importers quote as low as 6c. per lb. for this material.

Coal-Tar Products

Some improvement in buying of intermediates is noticeable, but competition for passing orders continues to hamper the advance in prices. Consumers are still operating conservatively and are not very anxious to take on any additional stocks beyond their present requirements. A moderate amount of selling is recorded in *nitraniline* around 79c. per lb. Some sellers ask up to 82c. per lb., but round lot business can probably be placed slightly under the 79c. level. The market on *dimethylaniline* has stiffened during the past few days and the lowest available quotation for second-hand goods is 42c. per lb., with some holders asking up to 45c. per lb. Most of the low-priced material has been well cleaned out of the market and with production greatly curtailed prices will probably remain firm. Quotations on *beta naphthol* are somewhat steadier, with resellers doing 32@33c. per lb. Makers are maintaining a firm attitude and quote 42c. per lb., although there are constant rumors that any actual round lot orders would not be refused down to 35c. per lb. Manufacturers' prices on *diethylaniline* are lower at $1@$1.10 per lb., with only a light demand noted. Makers of *aniline oil* are experiencing some difficulty in turning out large quantities on account of the scarcity of benzene. Figures from producers are quoted at 18@20c. per lb., according to quantity and brand. Resellers are offering material at 17½c. per lb. The retail market appears to have sufficient supplies on hand to meet all requirements and there were rumors around the trade of heavy cuts in quotations, even though the condition of the raw material market is quite uncertain. The demand for *benzoic acid* has fallen off and prices have come down accordingly. The technical is quoted at 50@58c. per lb. and the U.S.P. at 60@65c. The benzene market has continued in its recent firmness. Prices are quite varied, according to the seller. There are some holders asking as high as 49c. a gal. for the pure grade and even at this figure there is very little to be found. Refiners are unable to offer any material on the open market and are experiencing added difficulty in meeting old contracts. Supplies of *naphthalene* are being held by weak resellers, with the demand very light. Offers of flakes are heard around 6½c. per lb. Manufacturers are still maintaining their old figures of 8½@9½c. per lb. for the flake and 9½@10½ for the balls, with practically no real sales noted. The *phenol* market has taken on the quiet attitude of the rest of the crudes. Here and there an export inquiry is noted, but no round lot orders have been seen in the market for some time. Resale material is still held at prices ranging from 8¼@9c. per lb. Government surplus material is being maintained at 12@13c. per lb.

The St. Louis Market

ST. LOUIS, Sept. 30, 1921.

While the market on fine chemicals has been subject to slight fluctuations the past two weeks, the general tone has become much firmer. That the general impression that the bottom in price decline has been reached prevails is reflected in the buying of larger quantities of nearly every item. The market on heavy chemicals shows a similar improvement and many buyers have confidence enough to anticipate their requirements again.

Alkalis

Caustic soda remains in good demand with price of $4 per 100 lb., basis 73-75 per cent solid, f.o.b. point of production. *Soda ash* demand is still only fair and manufacturers' schedule prevails. *Bicarbonate of soda* and *sal soda* demand is light, with the former enjoying the better demand of the two, and holding at $2.60 per 100 lb. in less than carlots.

Industrials

Carbon bisulphide is in strong demand, with supplies scarce but prices remaining the same. *Aqua ammonia* demand is very good, with price the same. The *sulphur* demand is routine, with price the same, at $2.10 per 100 lb. for commercial, in bags.

Drugs and Pharmaceuticals

Bismuth salts continue to enjoy a good demand. *Salicylic acid* declined 2c., *sodium salicylate* has declined 3c. and *acetyl salicylic* has dropped 2c. per lb. respectively in the past two weeks. As the demand is no lighter, these declines are due to competition in manufacture. *Iodides* are in good demand, as are *bromides*. There is a general decline of 5c. per lb. on heavy *bromides*. The *sodium benzoate* demand has eased off. *Zinc stearate* is in good demand, with price the same. *Citric acid* is going normal, with price for imported citric the same as the domestic.

Acids

The market on 60 per cent *sulphuric acid* is quiet, with price at $15@$16 per ton. The market on the 66 per cent is active, with price still at $20 per ton. *Nitric acid* demand is quiet. *Hydrochloric* is very slow, with no change in price. The *mixed acids* are likewise very quiet. *Salt cake* enjoys the usual good seasonal demand, with the demand exceeding the available supplies and prices high and firm. On *zinc chloride*, the usual contract withdrawals are being made but no new business is being transacted.

Vegetable Oils

Castor oil remains in good demand at price of 11½c. per lb. in heavy returnable drums. *Linseed oil* reached a maximum of 83c. per gal., and has slowly declined and today is quoted at 76c. in cooperage, ex-warehouse, with the demand light. *Turpentine* demand remains the same, with price at 72½c. in 5-bbl. lots.

The Iron and Steel Market

PITTSBURGH, Sept. 30, 1921.

While the general condition of the steel market is probably better than a week ago, it is doubtful whether there is any increase in the actual volume of steel mill bookings, on account of two special factors, the large amount of business that was gathered up in wire products in connection with the advance in prices Sept. 12, and the heavy bookings in sheets in anticipation of the price advances that became effective last week. These two important branches of the finished steel market are naturally quiet at present, the production and shipments being of course heavier than formerly.

The formal reductions in pipe mill products a fortnight ago, chiefly by way of recognizing price cutting from the old lists but carrying some prices below any previous cut rates, does not seem to have had much direct effect upon the volume of demand, but there has been some increase, just as demand was increasing during August.

In bars, shapes and plates, the "heavy rolled products," the showing of the market is not quite clear. The reports commonly made are that business is light in all three lines, but there are some indications that a drive is being quietly made by a number of the mills to book customers up for the near future at special prices and in expectation of establishing slightly higher prices as the open market. It is rumored that on all three products some mills will give regular customers contracts to the end of the year, which virtually means price protection, at 1.60c., though what is openly admitted is only that desirable orders, with specifications attached, and for shipment at mill convenience, are acceptable at this figure.

Whatever may be the details in any given case it is now clear that the steel market as a whole has an upward rather than a downward trend. This condition is not based upon the same volume of demand that used to be required before the war to cause steel prices to advance or even become firm. It is based rather upon the fact of prices having gone farther below actual cost of production than producers are willing to countenance as a permanent condition. Before the war it used to be held that steel prices would not trend upward of their own accord unless mills had an actual operation of better than 75 per cent. In no branch of the finished steel trade, except possibly in sheets and wire products, is there an operation approaching that level, while in those two groups orders were placed by buyers under the spur of an expected price advance, and it is not proved that buying will be resumed at the advanced prices now ruling.

Steel Production

There has been little if any increase in steel production this week as compared with last week, and the general rate, in ingots, may be taken at approximately 33 per cent of capacity. The best demand has been in the lighter lines, sheets, wire products, tubular goods and tin plate, and accordingly the tonnage of steel production is not greatly affected. Bars, shapes, plates and rails show very light production. Probably an upward trend in steel production will continue for a few weeks, bringing about an operation of between 40 and 50 per cent, but unless some radical change occurs in fundamental conditions, such as inception of railroad buying on a fair scale or a large increase in construction work involving steel, no better rate is to be expected, and demand may even taper off in December and January, which are normally dull months in the trade.

The steel mills feel that the price liquidation in finished steel products has been carried too far. Taking the recent prices for wire products and sheets, and current prices for other products, a weighted average shows prices at only 31 per cent above the average level in 1913. The Bureau of Labor's index number of commodities at wholesale, with 1913 standing at 100, was 148 for July and 152 for August, showing an advance and also showing a higher level than obtains in steel, since the index number for steel would be 131.

Pig Iron and Coke

The pig iron markets throughout the country have continued firm, even though rather inactive. In eastern Pennsylvania there has been a slight advance in the week. The chief activity in the local market has been in purchases by the Standard Sanitary Manufacturing Co., which bought 5,000 tons of foundry iron for its Pittsburgh plant and an equal tonnage for its New Brighton plant, fourth quarter delivery, paying for nearly all the iron the regular price of $21 valley. The company also bought 5,000 tons for its Louisville plant, taking Southern iron at $19 Birmingham. Basic remains quotable at $19 to $20 valley, and bessemer at $20.

Connellsville coke is not quotably changed, at $3.25@$3.50 for furnace and $4.25@$4.75 for foundry, these prices being about 25c. above the average in July and August, the increase being supported by the recent wage advance. Demand on the whole is somewhat better, but the Connellsville trade has been disturbed by the selling of byproduct coke by steel works, requiring the capacity normally for their own requirements. Several operators, formerly indifferent, now seem willing to sell at cost in order to get into operation, trusting to future improvement for profits.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.40 – $0.45
Acetone	lb.	$0.12½ – $0.12½	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.75 – 3.00	3.25 – 3.50
Acetic, 56 per cent	100 lbs.	5.50 – 5.75	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.50 – 11.00	11.25 – 10.50
Boric, crystals	lb.	.12½ – .13	.13½ – .14
Boric, powder	lb.	.13 – .13½	.14 – .14½
Citric	lb.	–	.44½ – .46
Hydrochloric	100 lb.	1.25 – 1.50	1.60 – 1.75
Hydrofluoric, 52 per cent	lb.	.11½ – .11½	.12 – .12½
Lactic, 44 per cent tech	lb.	.09½ – .10	.10 – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C.P	lb.	3.25 – 3.50	3.60 – 4.00
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg	lb.	.06½ – .06½	.06½ – .07
Nitric, 42 deg	lb.	.06½ – .07	.07½ – .07½
Oxalic, crystals	lb.	.16 – .16½	.16½ – .17½
Phosphoric, 50 per cent solution	lb.	.13 – .13½	.14 – .18
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	–	1.75 – 1.90
Sulphuric, 60 deg., tank cars	ton	–	11.00 – 12.00
Sulphuric, 60 deg., drums	ton	–	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	–
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 – 22.00	–
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P	lb.	–	.75 – .85
Tannic (tech.)	lb.	.45 – .48	.50 – .55
Tartaric, imported crystals	lb.	–	.25 – .26
Tartaric acid, imported, powdered	lb.	–	.27 – .28
Tartaric acid, domestic	lb.	–	– .35
Tungstic, per lb. of WO	lb.	–	1.30 – 1.40
Alcohol, Ethyl	gal.	–	4.65 – 4.90
Alcohol, Methyl (see methanol)		–	–
Alcohol, denatured, 188 proof	gal.	–	.35 – .36
Alcohol, denatured, 190 proof	gal.	–	.37 – .38
Alum, ammonia, lump	lb.	.03½ – .03½	.04 – .04½
Alum, potash, lump	lb.	.03½ – .04	.04½ – .04½
Alum, chrome lump	lb.	.10 – .11	.11½ – .12½
Aluminum sulphate, commercial	lb.	.02 – .02½	.02½ – .02½
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07½	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammon iac)	lb.	.06 – .06½	.06½ – .07
Ammonium chloride, granular (gray salammon iac)	lb.	.06½ – .07	.07½ – .08
Ammonium nitrate	lb.	.07½ – .07½	.07½ – .08½
Ammonium sulphate	100 lb.	2.20 – 2.25	2.30 – 2.40
Amylacetate	gal.	–	3.25 – 3.50
Amylacetate tech	gal.	–	2.50 – 3.00
Arsenic oxide, (white arsenic) powdered	lb.	.05½ – .05½	.06 – .06½
Arsenic, sulphide, powdered (red arsenic)	lb.	.11 – .11½	.12 – .13
Barium chloride	ton	43.00 – 45.00	46.00 – 49.00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.07½ – .08	.08½ – .09
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .05
Bleaching powder (see calc. bypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.27 – .28	.28½ – .30
Calcium acetate	100 lbs.	2.00 – 2.05	–
Calcium carbide	lb.	.04½ – .04½	.05 – .05½
Calcium chloride, fused, lump	ton	23.50 – 24.00	24.50 – 25.50
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02½
Calcium bychlorite (bleach'g powder)	100 lb.	2.75 – 2.80	2.90 – 3.50
Calcium peroxide	lb.	–	1.40 – 1.50
Calcium phosphate, tribasic	lb.	–	.15 – .16
Camphor	lb.	–	.70 – .72
Carbon bisulphide	lb.	.06 – .06½	.06½ – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10½	.11 – .12
Carbonyl chloride, (phosgene)	lb.	–	.60 – .75
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	–	.38 – .43
Cobalt oxide	lb.	–	2.00 – 2.10
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.19 – .19½	.20 – .21
Copper cyanide	lb.	–	.50 – .62
Copper sulphate, crystals	lb.	.05 – .05½	.05½ – .06
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Ethyl Acetate Com. 85%	gal.	–	1.00 – 1.10
Ethyl Acetate pure (acetic ether, 98% to 100%)	lb.	–	.40 – .42
Formaldehyde, 40 per cent	lb.	.12 – .12½	.12½ – .13½
Fusel oil, ref	gal.	–	3.25 – 3.75
Fusel oil, crude	gal.	–	1.50 – 1.75
Glauber's salt (see sodium sulphate)		–	–
Glycerine, C. P. drums extra	lb.	–	.14½ – .15
Iodine, resublimed	lb.	–	3.50 – 3.60
Iron oxide, red	lb.	–	.10 – .20
Iron sulphate (copperas)	ton	18.00 – 19.00	20.00 – 23.00
Lead acetate	lb.	–	.10½ – .12½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	–	.15 – .20
Litharge	lb.	.07½ – .08	.08½ – .09
Lithium carbonate	lb.	–	1.30 – 1.40
Magnesium carbonate, technical	lb.	.08 – .08½	.09 – .10
Magnesium sulphate, U. S. P	100 lb.	2.50 – 2.75	–
Magnesium sulphate, technical	100 lb.	–	1.10 – 1.75
Methanol, 95%	gal.	–	.66 – .68
Methanol, 97%	gal.	–	.70 – .72
Nickel Salt, double	lb.	–	.12 – .12½
Nickel salt, single	lb.	–	.14 – .14½
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.40 – .41	.42 – .45
Phosphorus, yellow	lb.	–	.30 – .35
Potassium bichromate	lb.	.11 – .11½	.11½ – .12

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$.... – $....	$0.25½–$0.28
Potassium bromide, granular	lb.	..... –	.15 – .23
Potassium carbonate, U. S. P.	lb.	.20 – .21	.22 – .25
Potassium carbonate, 80–85%	lb.	.04 – .04½	.05 – .06
Potassium chlorate, crystals	lb.	.07 – .07¼	.07½ – .10
Potassium cyanide	lb.	..... –	.26 – .28
Potassium hydroxide (caustic potash)	lb.	.05¼– .05½	.06 – .08
Potassium muriate, 80% K.C.l	ton	40.00 – 42.50	..... – .....
Potassium iodide	lb.	..... –	2.60 – 2.75
Potassium nitrate	lb.	.09¼– .09½	.10 – .12½
Potassium permanganate	lb.	.20 – .21	.22 – .23
Potassium prussiate, red	lb.	.28 – .29	.29½– .30
Potassium prussiate, yellow	lb.	.20 – .20½	.21 – .22
Potassium sulphate (powdered)	per unit	..... –	1.20 – 1.25
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake (bulk)	ton	..... –	20.00 –25.00
Silver cyanide	oz.	..... –	1.35 – 1.38
Silver nitrate	oz.	..... –	.47 – .48
Soda ash, light	100 lb.	2.10 – 2.15	2.20 – 2.50
Soda ash, dense	100 lb.	2.35 – 2.40	2.45 – 2.70
Sodium acetate	lb.	.04 – .04½	.04½– .05
Sodium bicarbonate	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium bichromate	lb.	.07½– .08	.08½– .08¾
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½– .05	.05½– .06
Sodium borate (borax)	lb.	.05½– .06	.06½– .07
Sodium carbonate (soda)	100 lb.	1.90 – 2.00	2.10 – 2.40
Sodium chlorate	lb.	.07½– .07¾	.08 – .08½
Sodium cyanide	lb.	.24 – .25	.26 – .30
Sodium fluoride	lb.	.10½– .11	.11½– .12
Sodium hydroxide (caustic soda)	100 lb.	4.00 – 4.10	4.15 – 4.75
Sodium hyposulphite	lb.	..... –	.03½– .03¾
Sodium nitrate	100 lb.	2.20 –	2.35 – .....
Sodium nitrite	lb.	.06½– .07	.07½– .07¾
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½– .04½	.04¾– .05¼
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.21 – .24
Sodium prussiate, yellow	lb.	.13 – .13½	.13½– .13¾
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.15	1.25 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02½– .03	.03¼– .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04½– .04¾	.05 – .06
Sodium sulphite, crystals	lb.	.03½– .04	.04½– .04¾
Strontium nitrate, powdered	lb.	.12 – .13	.13½– .20
Sulphur chloride, red	lb.	.05 – .05½	.05½– .06½
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders ex	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	..... – .....
Tin oxide	lb.	..... –	.38 – .40
Zinc carbonate, precipitate	lb.	.16 – .16½	.17 – .17½
Zinc chloride, gran.	lb.	.09½– .09½	.10 – .11
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11½– .11½	.11½– .12½
Zinc oxide, XX	lb.	.07½– .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.15 — $1.20
Alpha-naphthol, refined	lb.	1.30 — 1.35
Alpha-naphthylamine	lb.	.30 — .35
Aniline oil, drums extra	lb.	.17½— .20
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.25
Benzidine, base	lb.	1.00 — 1.10
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.32 — .35
Beta-naphthylamine, sublimed	lb.	1.90 — 2.00
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .75
Cresylic acid, 95-97%, dark, in drums	gal.	.60 — .65
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.00 — 1.15
Dimethylaniline	lb.	.42 — .50
Dinitrobenzene	lb.	.25 — .28
Dinitroclorbenzene	lb.	.25 — .30
Dinitronaphthalene	lb.	.32 — .40
Dinitrophenol	lb.	.37 — .40
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.30 — .35
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.10 — 1.20
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.50 — 1.60
Naphthalene crushed, in bbls.	lb.	.06½— .07½
Naphthalene, flake	lb.	.06½— .08
Naphthalene, balls	lb.	.08 — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	3.00 — 3.10
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.21 — .25
Para-amidophenol, base	lb.	1.40 — 1.45
Para-amidophenol, HCl	lb.	1.70 — 1.80
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.79 — .82
Para-nitrotoluene	lb.	.80 — .85
Para-phenylenediamine	lb.	1.70 — 1.75
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.40 — .50
Phenol, U. S. P., drums	lb.	.08½— .10
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.50 — 1.60
Resorcinol, pure	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls.	lb.	.18 — .20
Salicylic acid, U. S. P.	lb.	.19 — .22
Salol	lb.	.60 — .70
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.27 — .30
Tolidine	lb.	1.30 — 1.35
Toluidine, mixed	lb.	.43 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.19 —	$0.20
Beeswax, refined, dark	lb.	.24 —	.25
Beeswax, refined, light	lb.	.28 —	.30
Beeswax, white pure	lb.	.36 —	.42
Candelilla wax	lb.	.24 —	.25
Carnauba, Flora	lb.	.48 —	.50
Carnauba, No. 2, North Country	lb.	.24 —	.25
Carnauba, No. 3, North Country	lb.	.14½—	.15
Japan	lb.	.24 —	.26
Montan, crude	lb.	.05 —	.05½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½—	.03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 —	.....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½—	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.03¾—	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04¼—	.05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05¼—	.06
Stearic acid, single pressed	lb.	.09½—	.....
Stearic acid, double pressed	lb.	.10½—	.....
Stearic acid, triple pressed	lb.	.11 —	.11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.55 —	5.65
Rosin E-I	280 lb.	5.75 —	6.25
Rosin K-N	280 lb.	6.35 —	6.75
Rosin W. G.-W. W.	280 lb.	6.90 —	7.40
Wood rosin, bbl.	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.75 —	.....
Wood turpentine, steam dist.	gal.	.73 —	.....
Wood turpentine, dest. dist.	gal.	.72 —	.....
Pine tar pitch, bbl.	200 lb.	..... —	6.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	11.00
Retort tar, bbl.	500 lb.	—	11.00
Rosin oil, first run	gal.	.35 —	.....
Rosin oil, second run	gal.	.37 —	.....
Rosin oil, third run	gal.	.44 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.993	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.37
70-72 deg., steel bbls. (85 lb.)	gal.	.35
68-70 deg., steel bbls. (85 lb.)	gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23

Crude Rubber

Para—Upriver fine	lb.	$0.21 —	.21½
Upriver coarse	lb.	.11½—	.12
Upriver caucho ball	lb.	.11½—	.12
Plantation—First latex crepe	lb.	.15½—	.15½
Ribbed smoked sheets	lb.	.15½—	.15½
Brown crepe, thin, clean	lb.	.15 —	.....
Amber crepe No. 1	lb.	.17 —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09½ —	$0.09½
Castor oil, AA, in bbls.	lb.	.11 —	.11½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.14½ —	.15
Cocoanut oil, Ceylon grade, in bbls.	lb.	.10 —	.10½
Cocoanut oil, Cochin grade, in bbls.	lb.	.10½ —	.11½
Corn oil, crude, in bbls.	lb.	.09 —	.09½
Cottonseed oil, crude (f. o. b. mill)	lb.	.08 —	.08½
Cottonseed oil, summer yellow	lb.	.10 —	.10½
Cottonseed oil, winter yellow	lb.	.10½ —	.11
Linseed oil, raw, car lots (domestic)	gal.	.73 —	.74
Linseed oil, raw, tank cars (domestic)	gal.	.67 —	.68
Linseed oil, in 5-bbl lots (domestic)	gal.	.76 —	.77

Olive oil, Denatured	gal.	$1.10 —	$1.20
Palm, Lagos	lb.	.08 —	.08½
Palm, Niger	lb.	.06½ —	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½ —	.09
Peanut oil, refined, in bbls	lb.	.11½ —	.11¾
Rapeseed oil, refined in bbls	gal.	.87 —	.89
Rapeseed oil, blown, in bbls	gal.	.91 —	.92
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07½ —	....
FISH *			
Light pressed menhaden	gal.	$0.40 —	....
Yellow bleached menhaden	gal.	.42 —	....
White bleached menhaden	gal.	.44 —	....
Blown menhaden	gal.	.48 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude, first grade, Missouri	net ton	7.00 —	....
Blanc fixe, dry	lb.	.04 —	.04½
Blanc fixe, pulp	net ton	45.00 —	55.00
Casein	lb.	.07 —	.10
Chalk, Precipitated, domestic, extra light	lb.	.04½ —	.05
Chalk, Precipitated, domestic, light	lb.	.04 —	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½ —	.04
Chalk, Precipitated, English, extra light	lb.	.04½ —	.05
Chalk, Precipitated, English, light	lb.	.04½ —	.05
Chalk, Precipitated, English, dense	lb.	.04 —	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50 —	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	12.00 —	20.00
China clay (kaolin), imported, powdered	net ton	25.00 —	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00 —	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00 —	16.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.06 —	.07
Graphite, Ceylon chip	lb.	.04½ —	.05
Graphite, high grade amorphous crude	lb.	.00½ —	.02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00 —	....
Kieselguhr, f.o.b. N.Y.	per ton	61.00 —	....
Magnesite, calcined	per ton	66.00 —	70.00
Pumice stone, imported, lump	lb.	.03 —	.40
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.50 —	.51
Shellac, orange superfine	lb.	.51 —	.52
Shellac, A. C. garnet	lb.	.44 —	.45
Shellac, T. N.	lb.	.44 —	.45
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	12.50 —	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50 —	11.00
Talc, imported	ton	30.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton		$50.00
Carborundum refractory brick, 9-in.	less than carlot	1.000	1250.00
	carload lots	1.000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton		52- 55
Chrome cement, 40–45% Cr_2O_3	net ton		30- 32
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton		33- 35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		35- 40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		30- 35
Magnesite brick, 9-in. straight	net ton		65- 70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000		40- 42
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000		42- 45
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000		35- 38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.11 —	....
Ferrochrome, per lb. of Cr. contained, 4–6% carbon, carlots	lb.	.11 —	.12
Ferromanganese, 76-80% Mn, domestic	gross ton	60.00 —	63.00
Ferromanganese, 76-80% Mn, English	gross ton	63.00 —	65.00
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	60.00 —	65.00
Ferrosilicon, 75%	gross ton	130.00 —	135.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	24.00 —	26.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	24.00 —	26.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	12.00 —	13.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	12.50 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.20 —	.21
Manganese ore, chemical (MnO_2)	net ton	50.00 —	55.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75 —	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.50
Aluminum, 98 to 99 per cent	24.5@25
Antimony, wholesale lots, Chinese and Japanese	4.60@4.70
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	26.50
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.50
Zinc, spot, New York	4.80@4.85
Zinc, spot, E. St. Louis	4.40

OTHER METALS

Silver (commercial)	oz.	$0.70½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	78.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00–60.00
Mercury	75 lb.	39.00–41.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.50
Copper bottoms	27.00
Copper rods	18.00@18.75
High brass wire	15.75
High brass rods	13.25
Low brass wire	17.25
Low brass rods	17.25
Brazed brass tubing	25.00
Brazed bronze tubing	22.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.50@10.00	9.25	9.50
Copper, heavy and wire	9.00@9.25	8.50	8.50
Copper, light and bottoms	7.50@8.00	7.50	7.25
Lead, heavy	3.25@3.50	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.25@4.50	4.50	5.00
Brass, light	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings	4.00@4.25	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.88	$2.88	$2.88
Soft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, ¼ to 1 in. thick	2.88	2.80	2.80

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

CAMDEN—H. M. Jones, El Dorado, Ark., and associates, are planning for the erection of a new oil refinery at Camden, to consist of 2 units, with initial daily output of about 500 bbl.

California

RICHMOND—The Pacific Sanitary Mfg. Co., Fifth and Hensley Sts., manufacturer of sanitary ware, will commence the immediate construction of a 1-story addition to its plant, 100 x 300 ft. The erection contract has been let to Carl Overa, 2105 Roosevelt St.

LOS ANGELES—The Los Angeles Fabricating Co. has filed plans for the erection of a new 1-story steel fabricating plant, 95 x 160 ft., estimated to cost about $80,000. The Austin Co., Los Angeles, has the construction contract.

VISTA—The Sierra Clay Products Co., Sparks, Nev., H. O. Hague, president, is planning for the construction of a new brick-manufacturing plant at its clay properties in the Truckee River canyon, near Vista. The initial plant will be supplemented at an early date by a works for the manufacture of pottery and other burned clay products.

Florida

LEESBURG—The Grass Fibre Pulp & Paper Corp., recently organized with a capital of $1,000,000, has construction under way on its new local plant to be equipped for the manufacture of paper pulp from sawgrass. The works will have an initial capacity of about 40 tons. It is planned to have the factory ready for operation at an early date. W. F. Stovall is president; and E. R. Lacey, vice-president and general manager.

Indiana

INDIANAPOLIS—The Parker Tire & Rubber Co., 264 Allen Ave., will hold in abeyance the completion of unit No. 2, at its tire-manufacturing plant. The foundation work for the structure has been completed; it will be 2-story, 100 x 600 ft., and is estimated to cost about $300,000, with machinery. Paul P. Parker is president. George L. Whitsit, company address, is engineer.

MARION—The Upland Flint Bottle Co. has resumed production at its plant, after a shutdown of several weeks, giving employment to about 250 men.

Kentucky

SMITHFIELD — The Ohio - Kentucky Fluorspar & Lead Co., recently organized, is planning for the installation of equipment on properties acquired, previously operated by the North American Co. The present plant has a capacity of about 150 tons per day, and this output will be doubled. The company is capitalized at $1,000,000. F. B. Moody is general manager.

Massachusetts

PEABODY—The Morse Blacking Co. has commenced the construction of an addition to its plant, 1-story, 22 x 125 ft. A portion of the structure will be equipped as a laboratory and the remainder for the manufacture of color-finishes for leather tanning work.

BOSTON—The Massachusetts Oil Co. is perfecting plans for the construction of a new branch works on Pequot Ave., New London, Conn.; it will consist of a number of buildings.

CHARLESTON—Fire, Sept. 16, destroyed a portion of the 3-story works of the Eastern Metal & Refining Co., 60 Boland St., with loss estimated at about $18,000.

Mississippi

JACKSON—The Central Cotton Oil Co. is reported to be planning for the immediate rebuilding of the portion of its plant, destroyed by fire Sept. 14, with loss estimated at about $75,000.

New Jersey

NEWARK—The Krepecraft Co., recently organized with a capital of $20,000, has leased a portion of the plant of the Universal Caster & Foundry Works, Jackson Ave., for the establishment of a new plant for the manufacture of crepe-paper products. The structure consists of a total of about 8,000 sq.ft. of floor space, and will be remodeled and equipped immediately for the new line of manufacture. The office of the company will be located at 129 Jackson Ave. Fred E. Rothermel and Fred Schuler head the company.

BELLEVILLE—The Bob White Chemical Co., 39 Broadway, New York, N. Y., is planning for the construction of a new plant in the vicinity of Belleville. Application for permission to erect the structure has been made to the local town officials. The company is perfecting plans for the erection of a new laboratory and works structure at Ogdensburg, N. Y. It was formerly known as the Morgan Chemical Co.

TRENTON—The Star Porcelain Co., Muirhead Ave., manufacturer of electrical porcelain products, is taking bids for the erection of a 1-story addition to its plant, 50 x 82 ft.

NEWARK—The Art Metal Works, 7 Mulberry St., is arranging for the immediate installation of a new gas-recovery system at its branch works at 45 Manufacturers Pl.

New York

ALBANY—The Pittsburgh Plate Glass Co., Pittsburgh, Pa., and 103 Hunters Point Ave., Long Island City, N. Y., has awarded a contract to Bame & Cardell, Central Ave., Albany, for the erection of a new local plant on Tivoli St., to be 2-story, 103 x 180 ft., and consisting of a factory, power house and warehouse.

MECHANICVILLE—Fire, Sept. 16, destroyed a portion of the plant of the Duffney Brick Co., including drying department, boiler and engine rooms, and other works departments, with loss estimated at close to $200,000, including equipment. The plant will be rebuilt.

SYRACUSE—The Onondaga Pottery Co., 1858 West Fayette St., has commenced excavations for its new pottery on Court St., for the manufacture of general ware, estimated to cost in excess of $300,000 with machinery. The building contract has been awarded to Dawson Bros., Union Bldg. B. E. Salisbury is president.

Ohio

CLEVELAND — The Rail Welding & Bonding Co., 2400 Woodland Ave., has awarded a contract to the Austin Co., 16122 Euclid Ave., for the erection of a 1-story and basement plant addition, 90 x 180 ft.

CUYAHOGA FALLS—The Duro Brick Mfg. Co. is perfecting plans for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about $75,000.

AKRON—The Mason Tire & Rubber Co. is arranging for enlargements in its plant to double, approximately, the present capacity. A portion of the present works will be remodeled to accommodate the installation of considerable new machinery. It is proposed to have the entire plant ready for service early in the coming year, with output of about 4,000 tires and 4,000 tubes per day.

CANTON—Fire, Sept. 14, destroyed a portion of the plant of the Republic Rubber Co., with loss estimated at about $20,000.

TOLEDO—The Spitzer Paper Box Co., 3501 Monroe St., has awarded a contract to the Henry J. Spieker Co., Elm and Utica Sts., for the erection of its proposed 3-story plant addition, 30 x 80 ft., estimated to cost about $50,000. George R. Rheinfrank, Gardner Bldg., is architect.

Oklahoma

MUSKOGEE—The Oklahoma Producing & Refining Co. is planning for extensions and improvements in its local oil refinery. It is proposed to increase the production by about 20,000 bbl. a month; a number of new stills will be installed, and the storage capacity increased to about 350,000 bbl. of crude oil and 110,000 bbl. of refined products. The work, including equipment, is estimated to cost about $150,000. Meadquarters of the company are at Tulsa, Okla.

Pennsylvania

READING — The Electric Manganese Steel Co. is completing plans for the erection of a new 1-story foundry in the Brush Valley section, to be 1-story, 40 x 140 ft., and estimated to cost about $50,000. It will be equipped for the manufacture of steel castings. William H. Dechant & Son, Baer Building, are engineers.

EASTON—The Forbes Aluminum Products Co., recently organized under Delaware laws with capital of $500,000, has plans in preparation for the erection of a new local plant, estimated to cost in excess of $100,000. The company is represented by the Corporation Trust Co. of America, du Pont Bldg.

NEW CASTLE—Frank A. Seiberling, president of the Lehigh Tire & Rubber Co., formerly the New Castle Tire & Rubber Co., is said to be negotiating for the purchase of the plant and property of the Portage Tire & Rubber Co., Portage, Ohio, now operating under a receivership, with an offer of $750,000 for the assets. Upon acquisition, the plant will be operated in conjunction with the local works. Mr. Seiberling was previously head of the Goodyear Tire & Rubber Co.

Tennessee

JELLICO—The Jellico Firebrick Co. is arranging for the immediate installation of new equipment at its plant for the manufacture of firebrick, facebrick and other burned clay products. The company recently filed articles of incorporation with a capital of $100,000. Frank L. Smith is secretary and treasurer.

Texas

MEXIA—The Mexia Refining Co., Telephone Exchange Bldg., has awarded a contract to Charles V. Miller, Fort Worth, Tex., for the erection of its proposed new local oil refinery. The plant will be equipped to develop an output of about 3,000 bbl. a day, and is estimated to cost about $250,000. The machinery installation is expected to aggregate $150,000 in cost. Construction will be inaugurated at once.

ROTAN—The Patton Cement Plaster Co., recently organized with a capital of $350,000, is arranging for the erection of a local plant for the production of plaster. It is proposed to develop a capacity of about 400 tons of material a day. An elevator, 75x300 ft., will be constructed. J. W. Patton is president, and E. W. Maben, secretary and treasurer.

MARSHALL—The Darco Corp., du Pont Bldg., Wilmington, Del., a subsidiary of the du Pont Powder Co., of the same address, has acquired a tract of property at Marshall, totaling 160 acres, to be used as a site for its proposed new plant for the manufacture of Darco, a product produced from lignite and to be used in connection with the manufacture of glucose and kindred specialties. The new plant is estimated to cost about $1,500,000, and will be equipped to give employment to about 500 men.

AUSTWELL—The Austwell Oil Mill Co. is reported to be planning for the immediate rebuilding of the portion of its plant, recently destroyed by fire.

GORMAN—The Shell Torpedo Co., recently organized, has commenced the erection of a new plant on local site for the manufacture of nitroglycerine and other explosive products. The initial works will have a capacity of 1,200 qt. of material per day. Frank Kirk is president, and A. W. Samberson, vice-president and general manager.

Utah

SALT LAKE CITY—The Utah Iron & Steel Co. has preliminary plans under way for the erection of a number of additions to its works at Midvale, Utah, to include a new blast furnace, sheet mill, general rolling mill and other subsidiary buildings, estimated to cost about $3,000,000, complete.

The company has increased its capital from $2,500,000 to $5,000,000, with 50,000 shares of common stock, no par value, to finance the expansion.

Virginia

BARBER—The Ohio C. Barber Lime Co., affiliated with the Ohio C. Barber Fertilizer Co., Akron, O., is now operating at its new local plant, producing lime from a natural deposit without burning. Extensive capacity is planned. The company was organized recently with a capital of $600,000. Clarence W. Perkins is president.

New Companies

THE BULLET PROOF & NON-SHATTERABLE GLASS CORP., New York, N. Y., has been incorporated with a capital of $500,000, to manufacture special glass products. The incorporators are B. C. Fox, S. Tekulsky and P. Abrams. The company is represented by Hartman, Sheridan & Tekulsky, 152 West 42d St.

THE ROGERS FOUNDRY CO., Detroit, Mich., has been incorporated with a capital of $35,000, to manufacture iron, steel and other metal castings. The incorporators are C. O. Rogers, Monroe, Mich.; William Reinhold and Alexander Hungler, 448 Yale St., Detroit.

THE BOLIVAR COTTON OIL CO., Bolivar, Tenn., has been incorporated with a capital of $75,000, to manufacture cotton oil products, with plant at Shelby, Miss. The incorporators are L. B. Wilkinson and C. T. Jacobs, both of Bolivar.

THE MOLDED PRODUCTS CO., Boston, Mass., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture composition and molded products of various kinds. Henry L. F. Kreger is president; and Bennett Sanderson, Littleton, Mass., treasurer.

WELSEY & CO., INC., Brooklyn, N. Y., has been incorporated with a capital of $20,000, to manufacture oils, greases, etc. The incorporators are M. V. and R. S. Welsey, and F. M. Hill. The company is represented by E. J. Treacy, 15 Park Row.

THE ESSENTIAL OIL CO., New York Ave. and Mulberry St., Trenton, N. J., has been incorporated with a capital of $250,000, to manufacture oil products. The incorporators are John F. Wharton, August G. Roegele and Harry J. Engels.

THE OHIO VALLEY FLUORSPAR CO., Cave In Rock, Ill., has been incorporated with a capital of $60,000, to operate fluorspar and other mineral properties and refineries. The incorporators are C. R. Hamilton, U. G. Gullett and C. E. Seward, Cave In Rock.

THE CHIPLEY LEATHER MFG. CO., Chipley, Fla., has been incorporated with a capital of $25,000, to manufacture leather products. A local plant in now in course of construction. J. B. Guess, Jr., is president; and W. H. Faust, secretary and treasurer.

THE PATUXENT CLAY PRODUCTS CO., 32 South Calvert St., Baltimore, Md., has been incorporated with a capital of $1,000,000, to mine and manufacture clay products; operate a refinery for metal ore reduction, and kindred manufacture. The incorporators are Henry N. Hanna, Arthur R. Kasson and Herbert W. Holmes.

THE TRINITY OIL CORP., Wilmington, Del., has been incorporated with a capital of $3,000,000, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE KAISER-RADICK CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are J. D. Kaiser, H. I. Dorn and C. M. Rose. The company is represented by Samuel Sperling, 1540 Broadway

THE CHEMICAL DEVELOPMENT CO., 73 Eppirt St., East Orange, N. J., has filed notice of organization to manufacture chemical products. Paul D. Manning, 133 Washington Ave., represents the company

THE PETROLEUM PRODUCTS CO., Jacksonville, Fla., has been incorporated with a capital of $25,000, to manufacture oil products. B. E. Bennett is president; H. R. Simcox, secretary; and J. G. Woods, treasurer.

THE PURE LINE CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals and affiliated products. The incorporators are I. Cole, J. F. Kunzman and S. F. Mead, 158 West 50th St.

THE VALLEY FOUNDRY CO., Cumberland R. I., has been incorporated with a capital of $50,000, to manufacture iron, steel and other metal castings. The incorporators are M. M. McKenna and Walter L. Simms, Cumberland; and Frank Gross, 120 Hutchings St., Roxbury, Mass.

THE NON-ACID FERTILIZER & CHEMICAL CO., Lakeland, Fla., has been incorporated with a capital of $600,000, to manufacture chemical and fertilizer products. C. W. Dean is president; H. E. Memminger, vice-president and treasurer; and T. L. Wilson, secretary, all of Lakeland.

THE SCHOENFELD-GUTTER CO., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture magnifying glass and other glass products. The incorporators are M. and P. Schoenfeld, and L. Gutter. The company is represented by D. E. Goldfarb, 35 Nassau St.

THE CHEMICAL SALES CO., 356 East Illinois St., Chicago, Ill., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture and deal in chemical products. The incorporators are Joseph Cohen and Aaron T. Rubin.

THE WATTS-JAY CO., Jacksonville, Fla., has been organized under state laws to manufacture fertilizer products. Lemuel P. Jay is president; and John W. Watts, Jr., secretary and treasurer, both of Jacksonville.

THE MOHAWK TANNING CO., Gloversville, N. Y., has been incorporated with a capital of $10,000, to manufacture leather products. The incorporators are S. F. Sackheim, M. Barnett and O. Brauns. The company is represented by W. S. Cassidy, Gloversville.

THE BEAR RUBBER MILLS CORP., San Antonio, Tex., has been incorporated under Delaware laws with capital of $1,000,000, to manufacture rubber products. The incorporators are Donald E. Cameron, Charles Massey and Claude J. Kelly, San Antonio. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE HAYWARD RUBBER CO., Philadelphia, Pa., has been incorporated under Delaware laws with a capital of $200,000, to manufacture tires and other rubber products. The incorporators are William C. and L. T. Zimmerman, Philadelphia; and E. C. Boyd, Wilmington, Del. The company is represented by Harry P. Joslyn, Ford Bldg., Wilmington.

THE FARADOX RADIUM LABORATORIES, INC., 1012 North Clark St., Chicago, Ill., has been incorporated with a capital of $30,000, to manufacture radium and radioactive products. The incorporators are Burrell J. Cramer, Frank D. Levan and Harry Linder.

THE JOHN & PETERSON OIL CORP., Tulsa, Okla., has been incorporated with a capital of $150,000, to manufacture petroleum products. The incorporators are Willard John, J. P. Peterson and Charles P. Yadon, all of Tulsa.

HERBERT S. MICHAEL, INC., 1701 North Charles St., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals and affiliated specialties. The incorporators are Herbert S. Michael, LeRoy R. Hatter and Clayton C. Dobbs.

THE AMERICAN BRASS & ALUMINUM FOUNDERS CO., 6833 South Irving Ave., Chicago, Ill., has been incorporated with a capital of $35,000, to manufacture brass, bronze, aluminum and other metal castings. The incorporators are Robert C. Fingol, Harry J. Sanding and Anton A. Sikora.

THE COLUMBIA REFINING CO., Cleveland, O., has been organized under Delaware laws to manufacture refined oil products. The incorporators are Roscoe M. Ewing, James L. Lind and R. C. Heil, Cleveland. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE THUNDERBOLT POWDER CO., Wilmington, Del., has been incorporated under state laws with capital of $100,000, to manufacture powder, explosives and kindred products. The company is represented by the Capital Trust Co., Dover, Del.

THE SUPERIOR ALUMINUM CORP., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture aluminum and other metal products. The incorporators are W. Bichwit, S. Brodsky and G. C. Woolf. The company is represented by J. L. Bernstein, 5 Beekman St.

THE OLEAN WASH PAINT & VARNISH REMOVER CO., Syracuse, N. Y., has been incorporated with a capital of $10,000, to manufacture chemical compounds and affiliated specialties. The incorporators are F. P. Malpass, G. W. Fox and E. L. Day. The company is represented by Higbee & Malpass, University Block, Syracuse.

THE T. C. OIL CORP., Columbia, S. C., has been incorporated under Delaware laws with a capital of $200,000, to manufacture refined oil products. The incorporators are R. A. Cooper and W. A. McSwain, Columbia; and T. C. Hadley, Montgomery, Ala. The company is represented by the American Guaranty & Trust Co., Wilmington, Del.

THE METALOY CO. OF BALTIMORE, Baltimore, Md., has been incorporated with a capital of $10,000, to manufacture metal products. The incorporators are John L. Brown, Louis S. Houghton and William B. Rearick, 1728 Mulliken St.

THE PALO MOTOR OIL CO., 38 North Clark St., Chicago, Ill., has been incorporated with a capital of 50 shares of stock, no par value, to manufacture petroleum products, lubricating oils, etc. The incorporators are Harry J. Myerson, William H. Treder and Harry Berger.

Capital Increases, Etc.

THE WORLD'S FERTILIZER PROCESS CO., Sharpsburg, Pa., manufacturer of fertilizer products, has filed notice of increase in capital from $200,000 to $500,000.

THE CORRUGATED PAPER PRODUCTS CO., 221 West 26th St., New York, N. Y., has filed notice of increase in capital from $25,000 to $125,000.

THE PORTAGE TIRE & RUBBER CO., Portage, O., has filed a petition in bankruptcy, with estimated liabilities stated at $1,705,000, and assets about $400,000.

THE ADVANCE COLOR CO., 833 Magnolia Ave., Elizabeth, N. J., has field a petition in bankruptcy.

THE ZEGLEN TIRE & RUBBER CO., 1346 Rawson St., Chicago, Ill., has filed notice of change of name to the Chicago City Rubber Works, Inc.

THE BISON CHEMICAL CO., Buffalo, N. Y., has filed notice of dissolution under state laws.

THE SUPERIOR CHEMICAL CO., Joliet, Ill., has filed notice of change of name to the Calbakpo Co., at the same time changing its headquarters to 4100 Fillmore St., Chicago, Ill.

THE FEDERAL CHEMICAL CO., Nitro, W. Va., has filed notice of increase in capital from $250,000 to $500,000.

DAVID E. ALLEN, INC., Yonkers, N. Y., operating a foundry for the manufacture of metal castings, has filed notice of increase in capital from $25,000 to $75,000.

THE MAGNOLIA PETROLEUM CO., Dallas, Tex., has filed notice of increase in capital from $15,994,941 to $27,460,134.

THE HAMILTON NOVELTY GLASS CO., 2344 West Harrison St., Chicago, Ill., has filed notice of change in name to the Hamilton Glass Co.

Manufacturers' Catalogs

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., has just received from the printer its catalog on "Wheeler Condensers," which illustrates and describes a complete line of condensers and accessories for stationary and marine service—including Wheeler condensers, vacuum pumps, centrifugal pumps, cooling towers, condenser tubes, feed-water heaters, etc. Among the recent engineering improvements are: A new design of a 26-in. vacuum surface condensing equipment adapted for engine work and dispensing with combined auxiliary pumps; the steam jet air pump, with combined inter-condenser and heater operating at a maximum efficiency without complicated and expensive accessories; the jet condenser, with expansion joint between condenser body and a turbine, and a centrifugal pump having a special vertically split casing. In a section devoted to Crescent Brand condenser tubes, the precision that enters into each step of the manufacture of the highest quality tubes is explained. A condenser data sheet is included with each copy.

THE AUTOMATIC & ELECTRIC FURNACES, LTD., London, has sent a copy of its new catalog describing Wild Barfield electric furnaces, showing the wide range now manufactured by this company. Attention is called to Bulletin 20, which has been written with the idea of explaining to works employees that the best results in hardened steel are obtained by hardening at the non-magnetic point.

THE BROWN HOISTING MACHINERY CO., Cleveland, O., has produced a new clam-

shell bucket which is a powerful digger and has manganese steel digging edges which can be replaced when worn. Bronze bushings are used and throughout the bucket is designed to reduce wear. This is all described in a leaflet which will be furnished upon request to anyone interested.

THE STEERE ENGINEERING CO., Detroit, Mich., has issueh a leaflet on Purifier Trays.

THE GRINNELL CO., INC., Providence, R. I., has issued two catalogs: One describing the complete line of textile driers manufactured by the drier division of this company, and the other giving data on the compartment driers used in the chemical, pharmaceutical, dyestuff and color industries. Illustrations and specifications are given. Copies will be sent to anyone interested.

THE COLORADO IRON WORKS CO., Denver, Col., is distributing two leaflets, on "The Skinner Roaster" and "The Akins Flotation and Aeration Machine."

THE DAYTON-DOWD CO., Quincy, Ill., announces its new catalog, No. 246, on centrifugal fire pumps. Numerous photographs of installations and tests are shown.

THE ASHLAND FIREBRICK CO., Ashland, Ky., calls attention to four bulletins which have just been published, on "Firebrick for Rotary Cement Kilns," "Boiler Settings," "Firebrick for Glass Plants" and "Refractories for Oil-Burning Furnaces."

THE YOUNGSTOWN BOILER & TANK CO., Youngstown, O., has issued Bulletin 400, covering its tanks for the storage of gasoline, alcohol, benzene, asphalt, grease, brine, fuel oil, water, oils, soap, benzine, chemicals, etc. Illustrations are given of the different types, and purposes, together with a table of capacities.

THE EASTON CAR & CONSTRUCTION CO., Easton, Pa., in its bulletin on "Quarry Car Practice" illustrates and describes cars used by cement mills.

THE CARRIER ENGINEERING CORP., Newark, N. J., issues each month an interesting booklet entitled "The Weather Vein." The May issue was called the "Drying Number," the June issue the "New Home Number," the July issue the "Dehumidification Number," the August issue "The Motion Picture Number," the September number the "Ceramic Number." Many interesting articles are included in these booklets on air conditioning to the practical requirements of industry.

THE PALO CO., New York City, has issued a leaflet on the New Spencer Abbe refractometer which is illustrated and described.

THE WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., in a leaflet just issued describes in detail the auto-transformer, switching mechanism, the contacts, the overload relays, and many other features of type A auto-starters.

THE MANISTEE IRON WORKS CO., Manistee, Mich., has issued Bulletin 7, on "Manistee Vacuum Evaporators." Single and multiple effect units are described, together with a general synopsis of the salt industry, past and present, and the principle and economy of vacuum evaporation as applied to concentration and crystalization.

THE DORR CO., New York, in Bulletin No. 16 illustrates and describes continuous agitation and continuous counter-current washing in the chemical industries.

THE DOVER BOILER WORKS, New York, has issued specification and notes on steel stacks and tanks for factories, power houses, office, loft and apartment buildings, etc. This booklet contains a practical non-technical form of specification, with supplementary shop notes for the use of architects and engineers.

THE AMERICAN ROLLING MILL CO., Middletown, O., has issued an attractive publication, "Armco in Picture and Fact." This is a well printed and bound piece of publicity on behalf of a well-known American product. Manufacture of ingot iron sheets is shown by a series of a hundred or more excellent photographs, each operation being described briefly in a caption. Then comes a section showing the various forms of roofing and roofing accessories, culvert pipe, small tanks, etc., which are made at the main plant. Finally about 80 pages are devoted to a comprehensive set of tables of weights of sheets and plates of various gages, lengths and finishes.

THE KEWANEE BOILER CO., Kewanee, Ill., has issued Catalog 76, covering complete data on Kewanee firebox boilers, including drawings and dimensions.

THE M. W. KELLOGG CO., New York, calls attention to a new attractive book on "Power Plant Piping." This company, which has been called upon to solve many intricate piping problems, has gathered the more important elements of this knowledge and has crystallized them into the story which is contained in this book. It deals with the scope of its service, specifications for piping, the different kinds of pipes and piping, the size and design of the piping system, expansion of pipes, fittings, flanges, flow of water and steam, joints, etc. Another publication just issued by this company is on "Kellogg Hammer Welding" which is a process of making leak-proof vessels for the chemical industries. Both these catalogs are well illustrated.

THE STANDARD CAP & SEAL CORP., Chicago, Ill., has issued a booklet on "Standard Capping Machines," both hand or power operated.

THE LINK-BELT CO., Chicago, Ill., in its new steel chain data book 475 describes the heavier rugged steel chains used for power transmission, and also elevating and conveying chains. In book 215 this company describes the Uniroll and Multiroll idlers, and give also the correct method of figuring belt conveyors, price lists which will enable the user to determine the cost of a complete conveyor or any portion of a conveyor, examples suggesting correct type of belt conveyors and illustrations of typical installations.

THE HARBISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., has issued a leaflet on "Metalkase Magnesite Brick" for electric steel furnaces.

F. J. RYAN & Co., Philadelphia, has issued two leaflets: "Mircs Universal Oil Burner" and "Mircs Oil Fired Portable Rivet Heating Furnace." Copies of these bulletins will be sent upon application.

THE DANIEL M. LUEHRS CO., Cleveland, O., has issued two circulars describing its patented electrically heated oil systems. The Oil-Roasting System was designed primarily for the roasting of food products in deep fat or vegetable oils and the Liquid Heat System was designed to maintain temperature in pipe lines, pumps, asphalt and tar roofing machinery, jacketed kettles and evaporators. The heart of these systems consist of the electric oil heater and method of controlling the temperature. The oil-roasting system can be adapted for such work as paraffine impregnation and the heating of paraffines and other solids having a melting point less than 550 deg. F. and which will melt free and not clog up the pump or heater. Inasmuch as the electric heaters operate at a temperature only a few degrees higher than the temperature of the oil leaving the heater, the danger from carbonizing is greatly reduced. This makes it possible to use this system where accurate temperature control is desired and where material is liable to injury due to high temperatures.

THE GEORGE J. HAGAN CO., Pittsburgh, Pa., has issued four new catalogs. Bulletin LF 103 is on liquid fuel burners for the generation of steam; Bulletin LF 104 is on auxiliary apparatus for storing, transporting and conditioning liquid fuels; Bulletin LF 102 is on oil burners for combination oil and gas burners for industrial furnace application, and Bulletin LF 105 is on standardized heat treating furnaces of the combustion type for steel hardening, carbonizing, and annealing—non-ferrous metal annealing and similar metal heating operations. Each booklet is well illustrated.

THE HARDINGE CO., New York, calls attention to Section 1 of its No. 7 catalog, which has been revised and which embraces both wet and dry grinding problems. This section deals with the principle of operation of the conical mill and gives a general description of its uses in the industrial, mining and special fields.

THE YARNALL-WARING CO., Philadelphia, Pa., in Bulletin 4-1401, with supplementary sheet 2, explains the recent development of Yarway balanced control valve in both angle and globe patterns, with several forms of operating mechanisms. This equipment was designed primarily for use in conjunction with Yarway Lea V-Notch recording meter, but is also used on heaters and tanks that need regulating equipment. Pamphlet DT-1601, which is entitled "Tight in Two Places," describes Yarway double tightening valves for use on acid lines, soot-blowing systems, for locomotive service and pneumatic systems in addition to boiler blow-off use. Copies will be sent to anyone interested, upon request.

BAKER & CO., INC., Newark, N. J., announces the publication of a booklet on platinum, which contains the historical summary of platinum, occurrence of platinum ore, the platinum metals and uses of platinum, its allied metals and alloys.

THE NASH ENGINEERING CO., South Norwalk, Conn., has issued two new bulletins, No. 16 describes and illustrates the Jennings hytor condensation motor-driven centrifugal pump, which is designed to handle condensate from steam-heating or drying systems. They may be used to handle any liquid which will not attack the pump interior. In Bulletin 17 the Jennings hytor air line vacuum heating pumps, electric motor drive, for use on air line vacuum heating system or any service requiring air to be exhausted under a vacuum not exceeding 20 in. of mercury are described and illustrated. The illustrations in both catalogs show the machinery in natural colors.

THE TITANIUM ALLOY MFG. CO., Niagara Falls, N. Y., in a leaflet announces the offering of the facilities of the Commercial Service Department of the physical, metallurgical and metallographic laboratories to manufacturers and others interested in metallurgical and mechanical lines.

THE RAILWAY & INDUSTRIAL ENGINEERING CO., Greensburg, Pa., is putting on the market a rocking cableway for handling materials which is described in a four-page booklet.

THE NEW ENGLAND TANK & TOWER CO., Everett, Mass., has issued a booklet, No. A-121, descriptive of a "Nett-Co." product, the direct-connected motor-driven agitator drive.

THE AJAX ELECTROTHERMIC CORP., Trenton, N. J., in a recently published circular treats the Ajax-Northrup high-frequency induction furnace as a laboratory tool, which is used for melting steel, brass, silver and other metals and for heat-treating, carbonizing, annealing, etc.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS will hold its thirty-eighth annual convention at the Washington Hotel, Washington, D. C., Oct. 24-26.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS is holding its fall meeting at Springfield, Mass., Oct. 5 to 7.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.